MFR PAPER 1186

Nominal Catch-Per-Unit Effort of Albacore, *Thunnus alalunga* (Bonnaterre), Caught by U.S. Jig Vessels During 1961-70

R. MICHAEL LAURS, HAROLD B. CLEMENS, and LARRY H. HREHA

ABSTRACT—Catch-per-unit effort data by time-area strata for the albacore, Thunnus alalunga (*Bonnaterre*), *fishery off the west coast of North America are presented for the years 1961-70. Results indicate that while the fishery may range from central Baja California, Mexico, to British Columbia, Canada, it is usually not continuous over this range, but rather is centered in more restricted regions in a given fishing season. Marked annual latitudinal variations in the fishery were apparent with the fishery mainly located in "southern" waters from central Baja California to San Francisco during 1961-65 and in "northern" waters off the Pacific Northwest during 1966-70. Very little variation among years in the offshore distribution of the fishery was indicated, and for the most part it was restricted to within 200-250 miles of the shore with highest catch rates frequently made within 100 miles of the coast. During "southern" fishery years, catch rates indicative of commercial concentrations of albacore were generally made 2-4 weeks earlier, during mid-June to early July, than during "northern" fishery years. Differences in the pattern of the seasonal distribution of the fishery were also apparent between "southern" and "northern" fishery years.*

A twofold variation was observed in the estimates of annual catch-per-unit effort over the 10-year period; however, relatively high catch rates with little variation were observed during the later years, 1967-70. During all of the years the concentration index was greater than 1.0, indicating that fishers tended to concentrate their effort in areas or periods where or when the average catch-per-unit effort was high.

INTRODUCTION

Catch-per-unit effort data by time-area strata are presented for the albacore, *Thunnus alalunga* (Bonneterre), fishery off the west coast of North America. They were collected by individual States and then merged and standardized. The results are unique in that they make available, for the first time, estimates of standardized catch-per-unit effort for the entire range of the fishery. This has been made possible by the cooperation of scientists from the National Oceanic and Atmospheric Administration; National Marine Fisheries Service; State of California Resources Agency, Department of Fish and Game; and Fish Commission of Oregon[1].

Many of the statistics for the U.S. albacore fishery have been published separately by the individual States (Clemens, 1955; Ayres and Meehan, 1963; Clemens and Craig, 1965; Meehan and Hreha, 1969; and Hreha, 1974). In this paper, data collected by the States during the years 1961-70 have been combined and uniformly standardized to provide additional information about the entire range of the fishery and to take into account any coast-wide variation in the characteristics of the fishing vessels, of the geographical and seasonal nature of the fishery, or of other factors which may influence estimates of nominal fishing effort.

R. Michael Laurs is with the Southwest Fisheries Center, National Marine Fisheries Service, NOAA, La Jolla, CA 92038. Harold B. Clemens is with the California Department of Fish and Game, Long Beach, CA 90802. Larry H. Hreha is with the Fish Commission of Oregon, Astoria, OR 97103.

[1]The Fish Commission of Oregon has since been incorporated into the Oregon Department of Fish and Wildlife.

SOURCE OF INFORMATION

The information about catch localities and nominal fishing effort was obtained from logbooks and from interviewing fishers on the waterfront. A voluntary logbook system has been used by the California Department of Fish and Game since 1954 (Craig, 1963), and information from both logbooks and interviews was available for albacore landed in California. Information for albacore landed in Oregon was available from interviews prior to 1967 and from interviews and voluntary logbooks from 1967-70. The number of such records used for standardizing the catch rates is summarized by year and time period in Table 1. Only statistics from albacore jig boats were dealt with because there were insufficient data from bait boats. Jig boats land approximately 75 percent of the annual U.S. commercial albacore catch (Clemens and Craig, 1965). The total logged jig boat catch was roughly 30 to 40 percent of the total jig boat landings.

METHODS

Great care was taken by the individual States to insure confidentiality of the records of individual fishing vessels. This was done by removing from the records the name of each vessel and any identification numbers which could be traced to it and by assigning a code number which was kept constant each year for a given boat.

The basic data included date, number of fish caught, 1° quadrangle

Table 1.—Combined number of logbooks and interview records available from albacore jig vessels for determining standardized catch rates.

Year	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1-15 June	2	3	4							
16-30	232	409	40	48		3	3		16	
1-15 July	1,126	1,902	1,320	1,328	459	226	100	2	207	274
16-31	885	2,215	1,266	2,075	1,303	688	811	1,260	1,646	891
1-15 August	599	1,581	1,650	1,415	1,184	760	777	1,156	1,723	1,407
16-31	305	1,177	1,027	867	1,001	478	751	1,131	1,171	1,049
1-15 September	282	945	725	647	871	321	487	610	556	960
16-30	304	451	442	652	754	309	278	659	656	625
1-15 October	107	469	310	462	506	246	74	495	304	381
16-31	52	188	194	303	386	96	78	307	381	194
1-15 November	11	17	65	197	191	33	8	41	238	91
16-30			16	47	29	6		8	137	28
1-15 December									66	1
16-31									4	
Year (season) total	3,905	9,357	7,059	8,041	6,684	3,166	3,367	5,669	7,105	5,901

within which vessel operated, boat length, gear type, and often sea surface temperature. Since the data were in several forms—magnetic tape, computer cards, handwritten listings, etc.—and in various formats, they were first put into a common format and on to magnetic tape. Data from individual States were then merged and checked by computer for duplication of records. The latter was done by searching to determine if there was more than one record, for the same day at the same location, of identical catches of albacore by boats of the same length. If so, which was true in only a small number of cases, duplicates were omitted and a final basic data tape was prepared.

A modified version of the computer program FPOW (Berude and Abramson, 1972) was used in the standardization of the nominal fishing effort within each year[2]. The theoretical development and operating characteristics of the FPOW program are described in Fox (1971). The basic model assumed in the program is:

$$C_{ij} = q_i f_{ij} \bar{P}_j \epsilon_{ij}$$

where C_{ij} is the catch of the i^{th} fishing treatment in the j^{th} time-area stratum, q_i is the catchability coefficient of the i^{th} treatment, f_{ij} is the amount of fishing effort expended by the i^{th} treatment in the j^{th} time-area stratum, $\bar{P}_j$ is the average population size in the j^{th} time-area stratum, and ϵ_{ij} is assumed to be a log-normally distributed random variable. It is assumed that: 1) effort is measured such that within each treatment q_i is constant, 2) the units of effort operate independently, and 3) there is no interaction between treatments and time-area strata.

A preliminary analysis indicated differences in fishing power among 1) vessel length, 2) time fished during the season, 3) geographic area of fishing, and 4) years. Although fishing power in reality is probably a continuous function of vessel length, in order to estimate relative fishing power, it is necessary to group the data into strata such that 1) within each class the catchability may be assumed constant, 2) the probability of isolation will be minimized, and 3) sufficient data for analysis will be available in each group.

Following these criteria, the fishing vessels were assigned to length classes, and a separate class was established for each 10-foot increment in length. For each vessel length class, catch and effort data for each year were accumulated by 3° latitude-longitude quadrangle and by 15-day period. Fishing power coefficients were then derived for each vessel length class. Statistically significant differences in fishing power were found among the several length classes and nominal fishing effort for all was standardized in terms of effort of a 45-foot jig boat, which is approximately the median vessel length for the albacore jig fleet.

In addition, apparent geographical and seasonal differences in fishing power were found. Paucity of the data on a coastwide basis precluded rigorous statistical analyses. However, subjective evaluation of the results indicated an apparent need to stratify the fishery in geographic areas, 1) north and 2) south of lat. 38°N (about San Francisco), and to stratify the fishing season into 1) early-season consisting of the months June, July, and August, and 2) late-season consisting of the months September, October, and November. To minimize the geographical and seasonal effects in the calculation of the overall catch-per-unit effort, four sets of fishing power coefficients were calculated, i.e., early-north, early-south, late-north, and late-south, for each vessel size class. The four sets of fishing power coefficients for each vessel size class are given in Table. 2.

In order to examine spatial-temporal variations in the distribution of the albacore fishery and to study fish-ocean relationships, it was desirable to derive estimates of the catch-per-unit effort on a 1° quadrangle basis. Estimates of the mean catch-per-unit effort were computed by a 15-day period and by a 1° quadrangle, applying the appropriate fishing power coefficients as follows:

Where i = region (1 = north, 2 = south)
j = season (1 = early, 2 = late)
k = vessel length class (1 = 30, 2 = 40, . . .)
l = locality, 1° square.

Let f_{ijk} = fishing power coefficient for k^{th} vessel class in ij^{th} stratum
C_{ijkl} = catch of k^{th} vessel class in l in ij^{th} stratum
e_{ijkl} = nominal effort of k^{th} vessel class in locality l in ij^{th} stratum
$C_{ij\cdot l} = \sum_k C_{ijkl}$
$E_{ij\cdot l} = \sum_k e_{ijkl} f_{ijk}$.

Then the standardized catch-per-unit effort, in terms of a 45-foot jig boat for a 1° quadrangle l will be

$$C_{ij\cdot l} / E_{ij\cdot l}$$

[2]Standardization procedures were carried out under the direction of William Fox with assistance by T. Mulitauaopele and J. Zweifel, Southwest Fisheries Center, National Marine Fisheries Service, NOAA, La Jolla, CA 92038.

and average catch-per-unit effort calculated from total catch and total effort over all strata will be

$$C/E = C..../E.... = \Sigma_i \Sigma_j \Sigma_l C_{ij \cdot l} / \Sigma_i \Sigma_j \Sigma_l E_{ij \cdot l},$$

while the average of all catch-per-unit effort for all vessel classes and time-area strata will be

$$C/E = \Sigma_i \Sigma_j \Sigma_l C_{ij \cdot l} / E_{ij \cdot l} / N,$$

where N = number of strata.

The estimates of mean catch-per-unit effort by 15-day period and by 1° quadrangle are given in Figures 1 to 10. We emphasize that the catch rates presented in the figures are based on data only from those vessels for which logbooks or interviews were available; however, we assume they are representative of the entire fleet of jig boats. Further, we wish to point out that 1) the catches were not evenly distributed within the time periods, and 2) the schools of albacore were not uniformly distributed throughout each 1° quadrangle.

RESULTS

Charts of catch-per-unit effort in terms of a 45-foot jig boat by 15-day period and 1° quadrangle are given in Figures 1-10. Some general comments will be made concerning the data given in the figures, including 1) the annual latitudinal variation in the distribution of the fishery, 2) the offshore distribution of the fishery, and 3) the seasonal development of the fishery. A detailed analysis of the charts will not be given. Readers can draw their own conclusions depending on their intended use of the charts. Estimates of the mean standardized catch-per-unit effort and concentration index by years are also presented.

Annual Latitudinal Variation in the Distribution of the Fishery

Although the jig fishery for albacore ranged from central Baja California, Mexico, to British Columbia, Canada, usually it was not continuous or evenly distributed over this area (Figs. 1-10). Instead, fishing was centered in relatively restricted regions which varied in location both within and between seasons. Marked annual latitudinal variations in the location of the center of the fishery are also clearly evident in the figures. For example, during the period 1961-65 most fishing took place south of San Francisco. In these "southern" waters the geographic range of the fishery was greater and the catch rates usually higher than to the north (Figs. 1-5). By 1966, however, a major part of the fishery had shifted to "northern" waters above San Francisco, where the extent of the fishery and the catch rates were much greater than to the south—these conditions persisted through 1970 (Figs. 6-10).

Annual variations in location of the albacore fishery have been observed over at least the past three decades. They are indicated in Figure 11 (from Laurs, 1971), which gives the percentage of the west coast albacore tuna catch taken north of San Francisco for the years 1938-70. According to Laurs et al. (1974), based on unpublished work by James Renner[3], these variations appear to be related to marine environmental conditions during spring months in the offshore waters through which albacore presumably pass during their migration from the central Pacific into the west coast fishing grounds.

Variation in the location of the fishery has affected the amount of albacore landed in the individual Pacific

[3]Southwest fisheries Center, NMFS, NOAA, La Jolla, CA 92038, pers. commun.

Table 2.—Fishing power coefficients for each vessel size class for early season north of lat. 38°N, late season north of lat.38°N, early season south of lat. 38°N, and late season south of lat. 38°N.

Vessel size class	Early north	Late north	Early south	Late south	Vessel size class	Early north	Late north	Early south	Late south
1961					1966				
25	—	—	—	—	25	—	—	0.430	—
35	—	—	0.572	0.622	35	0.773	0.241	0.743	0.650
45	1.000	1.000	1.000	1.000	45	1.000	1.000	1.000	1.000
55	0.574	1.891	0.986	0.733	55	0.929	1.095	0.701	1.328
65	—	—	0.807	0.695	65	1.242	0.717	1.193	0.957
75	—	—	1.078	—	75	1.098	—	0.091	0.711
85	—	—	—	—	85	0.612	—	0.927	—
95	—	—	—	—	95	—	—	—	—
105	—	—	—	—	105	—	0.116	—	2.287
1962					1967				
25	—	—	—	—	25	—	—	—	—
35	0.718	1.520	0.864	0.948	35	0.492	0.930	0.794	0.722
45	1.000	1.000	1.000	1.000	45	1.000	1.000	1.000	1.000
55	0.737	0.566	1.191	1.032	55	0.980	1.379	0.981	—
65	0.713	0.822	0.993	0.971	65	0.906	0.468	1.169	0.915
75	1.617	0.624	—	—	75	0.863	0.242	—	—
85	—	—	—	—	85	1.131	0.505	0.893	0.135
95	—	—	—	—	95	—	—	—	—
105	0.663	—	—	—	105	—	—	—	—
1963					1968				
25	—	—	0.219	—	25	—	—	—	—
35	—	1.074	0.461	0.386	35	0.675	0.594	1.081	0.493
45	1.000	1.000	1.000	1.000	45	1.000	1.000	1.000	1.000
55	—	0.829	0.936	0.978	55	0.895	0.663	0.505	0.839
65	—	0.575	0.767	0.612	65	0.821	1.213	0.289	0.438
75	—	0.949	0.793	—	75	0.980	1.174	1.810	0.724
85	—	—	—	—	85	0.597	—	—	—
95	—	—	—	—	95	1.327	—	—	—
105	—	0.657	0.370	—	105	0.995	0.593	—	0.454
1964					1969				
25	—	—	0.449	0.114	25	—	—	—	—
35	0.332	0.561	0.616	0.425	35	0.941	0.882	0.606	0.893
45	1.000	1.000	1.000	1.000	45	1.000	1.000	1.000	1.000
55	0.862	1.210	0.814	1.089	55	1.103	1.197	0.591	0.667
65	0.599	0.854	0.909	0.606	65	0.988	0.443	1.877	0.822
75	—	1.428	0.387	—	75	1.260	0.459	—	0.975
85	—	—	1.630	0.217	85	1.372	—	—	—
95	—	—	—	—	95	—	—	—	—
105	—	0.954	0.817	0.612	105	0.819	—	0.567	—
1965					1970				
25	—	—	0.351	0.090	25	—	—	—	—
35	0.490	0.857	0.566	0.483	35	0.427	0.903	0.641	0.677
45	1.000	1.000	1.000	1.000	45	1.000	1.000	1.000	1.000
55	0.667	1.243	1.032	0.578	55	0.992	2.888	0.761	0.766
65	0.670	1.394	1.227	0.906	65	1.069	1.003	0.878	1.170
75	—	—	—	1.001	75	1.014	1.747	0.532	0.820
85	—	—	—	—	85	0.443	—	—	—
95	—	—	—	—	95	—	—	—	—
105	0.731	2.638	0.597	0.798	105	0.162	0.335	0.402	0.781

Coast States. For example, during the 1961-65 "southern" fishery years, landings in California ranged from 23.22 to 48.86 million pounds, while landings in Oregon ranged from 3.25 to 12.12 million pounds. However, during the 1966-70 "northern" fishery years, landings in California decreased, ranging from 14.72 to 29.93 million pounds while landings in Oregon increased, ranging from 17.68 to 37.75 million pounds. Albacore landings in Washington also were highest when the fishery was centered to the north (Table 3).

Table 3.—Amount of albacore landed by state (in millions of pounds)[1].

Year	Calif.	Oreg.	Wash.	Total
1961	29.12	3.25	0.46	32.83
1962	36.62	8.95	0.37	45.94
1963	48.86	11.40	0.53	60.79
1964	42.55	4.46	1.05	48.06
1965	23.22	12.12	1.87	37.21
1966	18.19	17.68	1.10	36.97
1967	17.86	29.24	1.24	48.34
1968	15.08	37.75	3.05	55.88
1969	14.72	29.83	3.56	48.11
1970	29.93	21.80	4.39	56.12

[1]Sources of information: Power (1963), Powell and Lyles (1964), Lyles (1965, 1966, 1967, 1968, 1969), U.S. Department of Commerce (1971), and Wheeland (1972, 1973).

The Offshore Distribution of the Fishery

Little variation was apparent in the offshore distribution of the albacore fishery (Figs. 1-10). Most fishing occurred within 200-250 miles of shore, with the highest catch rates frequently made within 100 miles of the coast. However, there was generally a strip of varying width along the coast which was void of albacore catches. The width of this strip was often greatest off northern California and Oregon where it sometimes extended 50 or more miles offshore.

According to several authors (Clemens, 1961; Pearcy and Muller, 1969; Flittner, 1970; Panshin, 1971; Laurs, 1973; and others), albacore may avoid nearshore waters off the coast of North America because water temperatures there are below those considered optimal for albacore (Laevastu and Rosa, 1963). These cool coastal waters result from coastal upwelling (Smith, 1968) and the nearshore areas which were devoid of albacore catches extended the farthest offshore where upwelling has been found to be strongest (Bakun, 1973).

Seasonal Development of the Fishery

General information about the seasonal development of the albacore fishery and its year-to-year variations can be obtained from the charts of catch-per-unit effort. However, since there is a complicated interplay of numerous factors (including availability of albacore, socioeconomic, weather, oceanographic conditions, etc.) that may influence the catch rates, care should be exercised if the charts are used to evaluate such events as the beginning or end of the fishery for specific years, within-season variations, etc.

It can be seen in Figures 1-10 that the albacore jig fishery is seasonal, generally lasting from July through October, although some catches were made as early as the first half of June (Figs. 2 and 3) and as late as mid-December (Fig. 10). During "southern" fishery years, catches indicative of commercial concentrations (catch rates of about 100 fish per day) were often made beginning in mid-June to early July (Figs. 1-5). This is about 2-4 weeks earlier than during the "northern" fishery years when significant catches usually were not made until after mid-July (Figs. 6-10).

There were also differences in the pattern of the seasonal distribution of the fishery between "southern" and "northern" fishery years. During most "southern" years a single fishing center was observed (Figs. 1-5). It expanded, generally moved northward, and then contracted during the fishing season. The fishery usually began between northern Baja California and southern California, expanded northward up the coast during the late summer and early fall months to northern California or Oregon, and then receded southward during the late fall to off central California where the fishing season usually ended. A different pattern was observed during most "northern" fishery years (Figs. 6-10) when two widely separated fishing areas prevailed from the beginning of the season through the late summer months. One of these areas was off the Pacific Northwest and one off southern California, with the former occupying a larger geographic area and having generally higher catch rates than the latter. By early fall, the southern area had shifted northward and the northern area southward, forming a single area off central California where the fishing season usually ended in the late fall.

Annual Standardized Catch-Per-Unit Effort

Estimates of annual standardized catch-per-unit effort were derived to provide information on the trends in albacore fishing success. These estimates were based on data for the period 1 July to 31 October and were derived in two ways: 1) the total catch divided by the total standardized effort,

$$CPUE_1 = \Sigma C / \Sigma f, \qquad (1)$$

and 2) the sum of the *CPUE* for each time-area stratum divided by the number of strata,

$$CPUE_2 = \frac{1}{n} \Sigma C/f \qquad (2)$$

where C denotes catch, f denotes nominal standardized effort, and n denotes the number of time-area strata.

Estimates of the annual standardized catch-per-unit effort based on Equations (1) and (2) above are given in Table 4 and Figure 12.

A two-fold variation in the annual catch-per-effort of albacore was observed during 1961-70. The ratio of averages *CPUE* statistic ranged from 69.24 to 136.99 fish per day, and the average of ratios *CPUE* statistic ranged from 61.24 to 119.03 fish per day. Both estimates of catch-per-unit effort were relatively low in 1961 and 1964-66, and high in 1962-63 and 1967-70 (Fig. 12).

Annual Concentration Index

To obtain a measure of the extent to which the albacore jig fleet has been successful in concentrating nominal effort in areas where or when average catch-per-unit effort has been high, computations were made for each year of the concentration index (Gulland, 1955). This index is the ratio of the ratio of averages *CPUE* statistic, Equation (1), to the average of ratios *CPUE* statistic, Equation (2):

Table 4.—Annual values of standardized fishing effort, logged catch, catch-per-unit effort, and concentration index for the U.S. albacore jigfishery during 1961-70.

Year[1]	Effort[2]	Catch[3]	[4]$CPUE_1$	[5]$CPUE_2$	Concentration index
1961	3,542.2	245,438	69.24	61.24	1.13
1962	9,236.4	1,151,957	124.72	112.55	1.11
1963	5,797.7	772,474	133.24	119.03	1.12
1964	7,102.8	697,331	98.18	76.26	1.29
1965	6,042.5	547,063	90.54	63.25	1.43
1966	3,019.4	276,148	91.46	62.27	1.47
1967	3,249.9	411,046	126.48	90.14	1.40
1968	5,322.7	729,165	136.99	93.97	1.46
1969	6,529.6	754,236	115.51	72.49	1.59
1970	5,308.0	680,083	128.12	88.12	1.45

[1] For period 1 July to 31 October.
[2] Standardized boat-day of logged effort.
[3] Number of logged fish.
[4] Ratio of averages *CPUE* derived using Equation (1).
[5] Average of ratios *CPUE* derived using Equation (2).

$$Ig = [\Sigma C/\Sigma f]\,[1/n\Sigma C/f]^{-1}.$$

During each year the concentration index (*Ig*) was greater than 1.0, ranging from 1.11 to 1.59 (Table 3). The values of *Ig* fall into two categories 1) one for the years of 1961-63 and 2) another for the years 1965-70. The values in the secondary category are higher than those in the first, and within each category the values are very stable. These results indicate that 1) each year albacore fishers tended to concentrate their effort in areas or period having a high average catch-per-unit effort presumably on relatively high densities of available albacore, and 2) they were relatively more successful in doing so during the years 1965-70 than during 1961-64.

LITERATURE CITED

Ayres, R. J., and J. Meehan. 1963. Catch locality, fishing effort, and length-frequency data for albacore tuna landed in Oregon, 1951-60. Fish Comm. Oreg. Invest. Rep. 2, 180 p.

Bakun, A. 1973. Coastal upwelling indices, west coast of North America, 1946-71. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-671, 103 p.

Berude, C. L., and N. J. Abramson. 1972. Relative fishing power, CDC 6600,FORTRAN IV. Trans. Am. Fish. Soc. 101:133.

Clemens, H. B. 1955. Catch localities for Pacific albacore (*Thunnus germo*) landed in California, 1951 through 1953. Calif. Dep. Fish Game, Fish Bull. 100, 28 p.

_____. 1961. The migration, age, and growth of Pacific albacore (*Thunnus germo*), 1951-1958. Calif. Dep. Fish Game, Fish Bull. 115, 128 p.

Clemens, H. B., and W. L. Craig. 1965. An analysis of California's albacore fishing. Calif. Dep. Fish Game, Fish Bull. 128, 301 p.

Craig, W. L. 1963. The California albacore fishery logbook system. FAO Fish Rep. 6: 1217-1225.

Flittner, G. A. 1970. Forecasting availability of albacore tuna in the eastern Pacific Ocean. *In* T. Laevastu and I. Hela (editors), Fisheries oceanography, p. 116-129. Fishing News (Books) Ltd., Lond.

Fox, W. W., Jr. 1971. User's guide to FPØW: A computer program for estimating relative fishing power and relative population density by the method of analysis of variance. Univ. Wash., Quant. Sci. Pap. 27, 6 p.

Gulland, J. A. 1955. Estimation of growth and mortality in commercial fish populations. Fish. Invest. Minist. Agric. Fish. Food (G.B.) Ser. II, 18(9), 46 p.

Hreha, L. H. 1974. Oregon albacore tuna fishery statistics, 1968-72. Fish Comm. Oreg., Data Rep. 5, 120 p.

Laurs, R. M. 1971. Temperate tuna forecast for 1971. Calif. Fish Market News Monthly Summary—Part 2-Fishing Information, Natl. Mar. Fish. Serv., La Jolla, Calif., May 1971, p. 1-10.

_____. 1973. Requirements of fishery scientists for processed oceanographic information. Proceedings from WMO Tech. Conf., Tokyo, 2-7 October 1972. WMO 346:95-111.

Laurs, R. M., R. J. Lynn, and N. E. Clark. 1974. Albacore tuna forecasting/monitoring at the La Jolla Laboratory. Natl. Mar. Fish. Serv., Southwest Fisheries Center, Admin. Rep. LJ-74-14, 35 p.

Laevastu, T., and H. Rosa, Jr. 1963. Distribution and relative abundance of tunas in relation to their environment. FAO Fish Rep. 6:1835-1851.

Lyles, C. H. 1965. Fishery statistics of the United States, 1963. U.S. Fish Wildl. Serv., Stat. Dig. 57, 522 p.

_____. 1966. Fishery statistics of the United States, 1964. U.S. Fish Wildl. Serv., Stat. Dig. 58, 541 p.

_____. 1967. Fishery statistics of the United States, 1965. U.S. Fish Wildl. Serv., Stat. Dig. 59, 756 p.

_____. 1968. Fishery statistics of the United States, 1966. U.S. Fish Wildl. Serv., Stat. Dig. 60, 679 p.

_____. 1969. Fishery statistics of the United States, 1967. U.S. Fish Wildl. Serv., Stat. Dig. 61, 490 p.

Meehan, J. M., and L. H. Hreha. 1969. Oregon albacore tuna fishery statistics, 1961-67. Fish Comm. Oreg., Data Rep. 1, 143 p.

Panshin, D. A. 1971. Albacore tuna catches in the northeast Pacific during summer 1969 as related to selected ocean conditions. Ph.D. Thesis, Oreg. State Univ., Corvallis, 120 p.

Pearcy, W. G., and J. L. Mueller. 1969. Upwelling, Columbia River plume and albacore tuna. Proc. Sixth International Symposium on Remote Sensing of Environment, Univ. Mich., Ann Arbor, p. 1101-1113.

Power, E. A. 1963. Fishery statistics of the United States, 1961. U.S. Fish Wildl. Serv., Stat. Dig. 54, 460 p.

Power, E. A., and C. H. Lyles. 1964. Fishery statistics of the United States, 1962. U.S. Fish Wildl. Serv., Stat. Dig. 56, 466 p.

Smith, R. L. 1968. Upwelling. Oceanogr. Mar. Biol., Annu. Rev. 6:11-46.

U.S. Department of Commerce. 1971. Fishery statistics of the United States, 1968. Natl. Mar. Fish. Serv., Stat. Dig. 62, 578 p.

Wheeland, H. A. 1972. Fishery statistics of the United States, 1969. Natl. Mar. Fish. Serv., Stat. Dig. 63, 474 p.

_____. 1973. Fishery statistics of the United States, 1970. Natl. Mar. Fish. Serv., Stat. Dig. 64, 489 p.

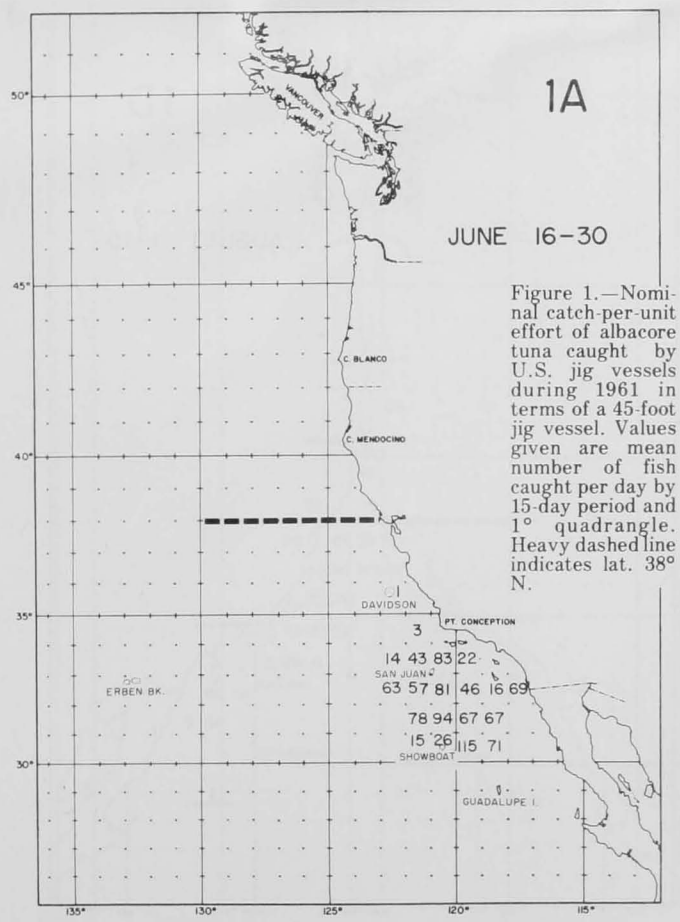
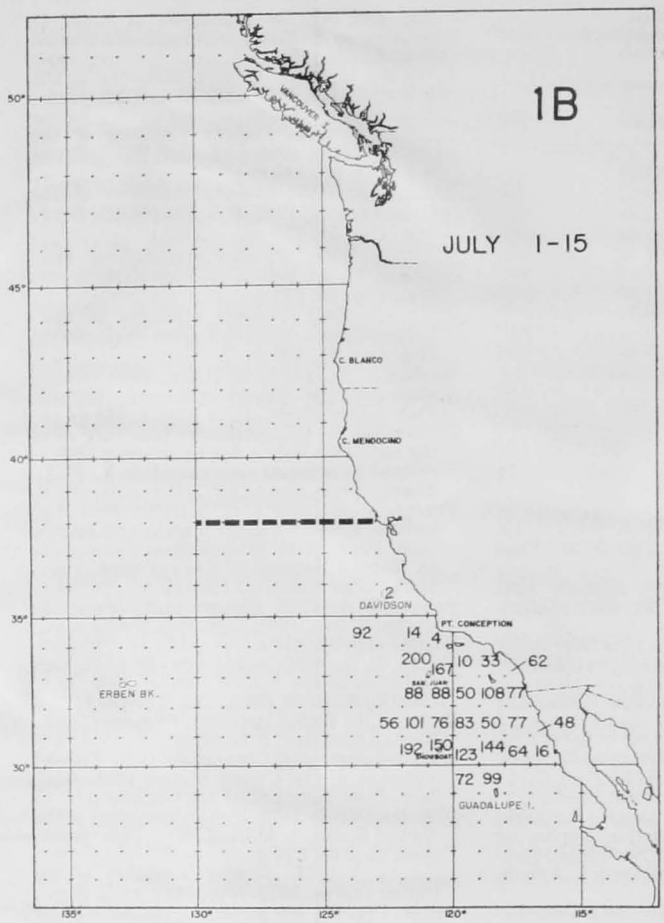
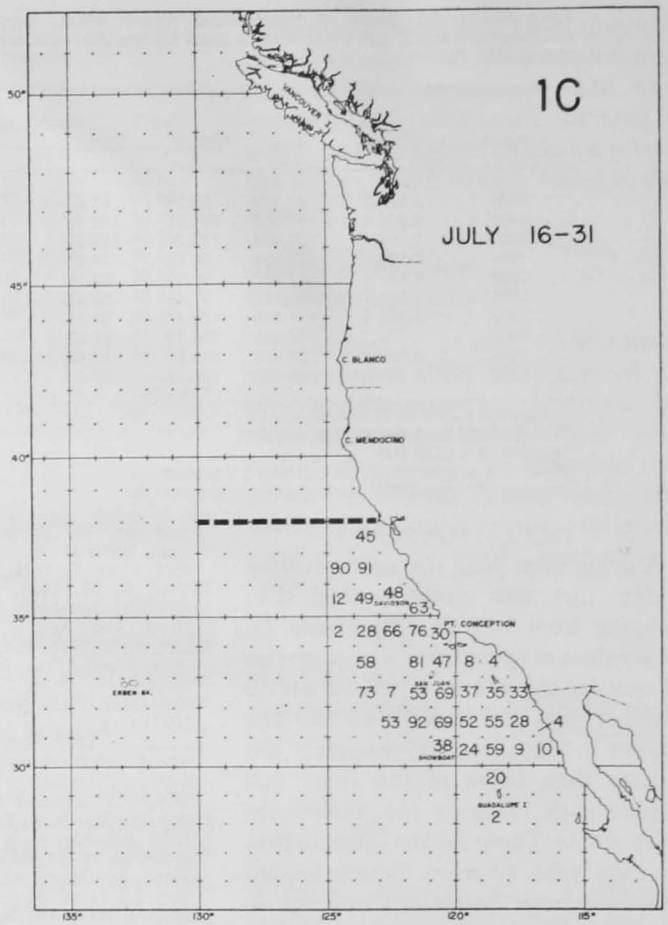
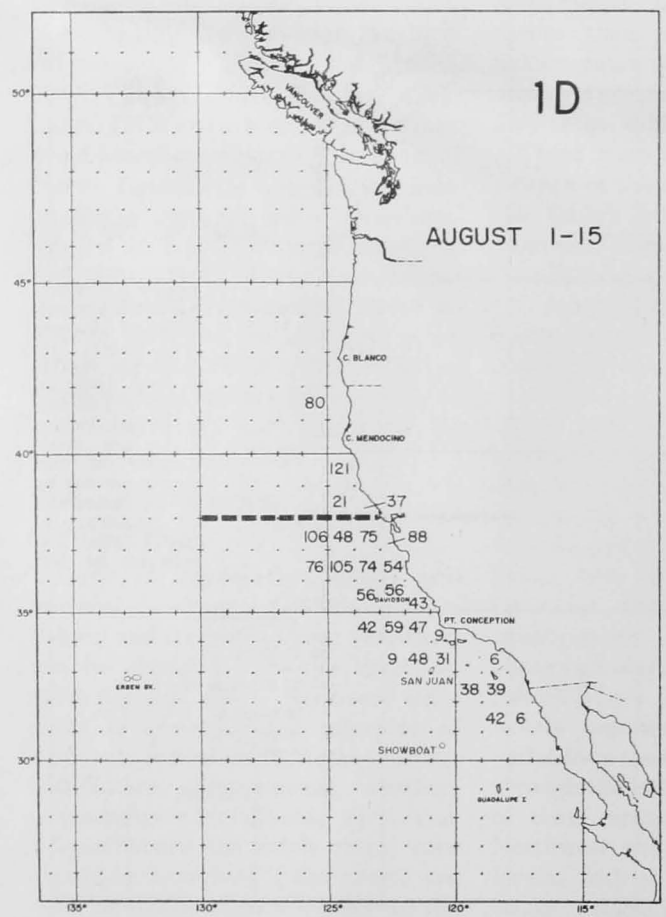
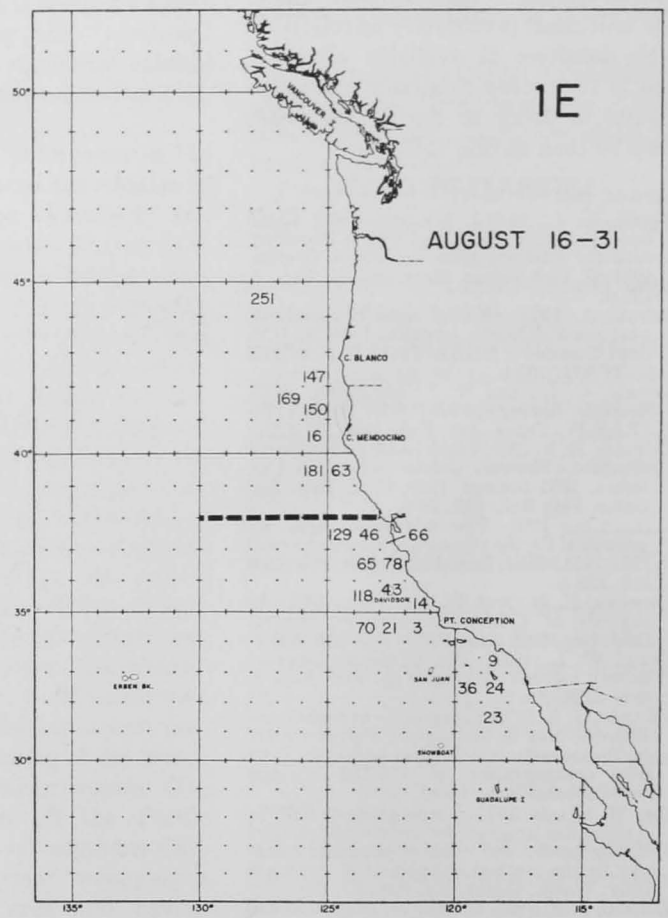


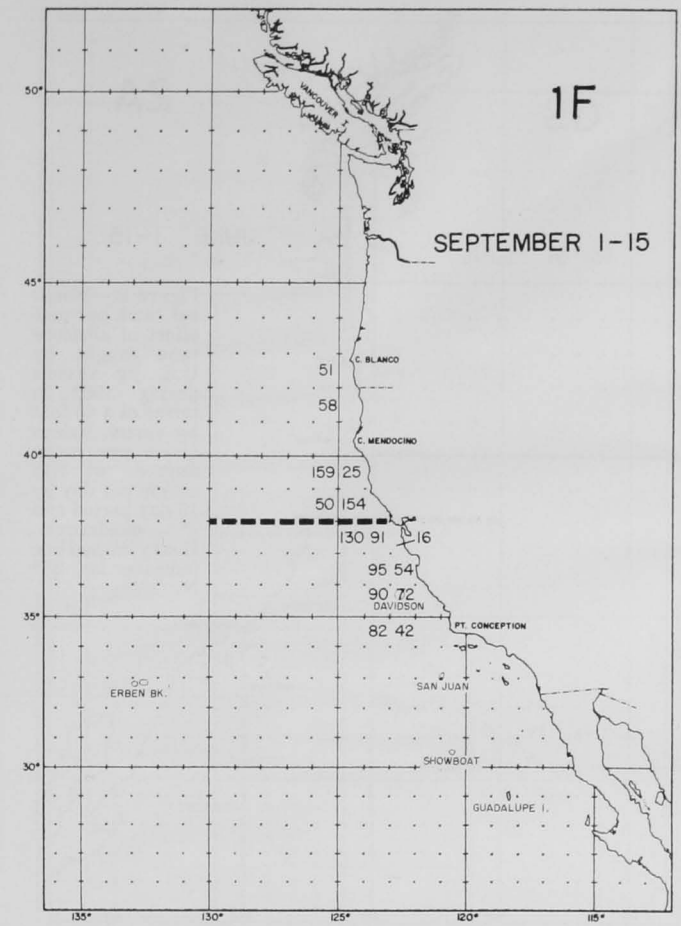
Figure 1.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1961 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

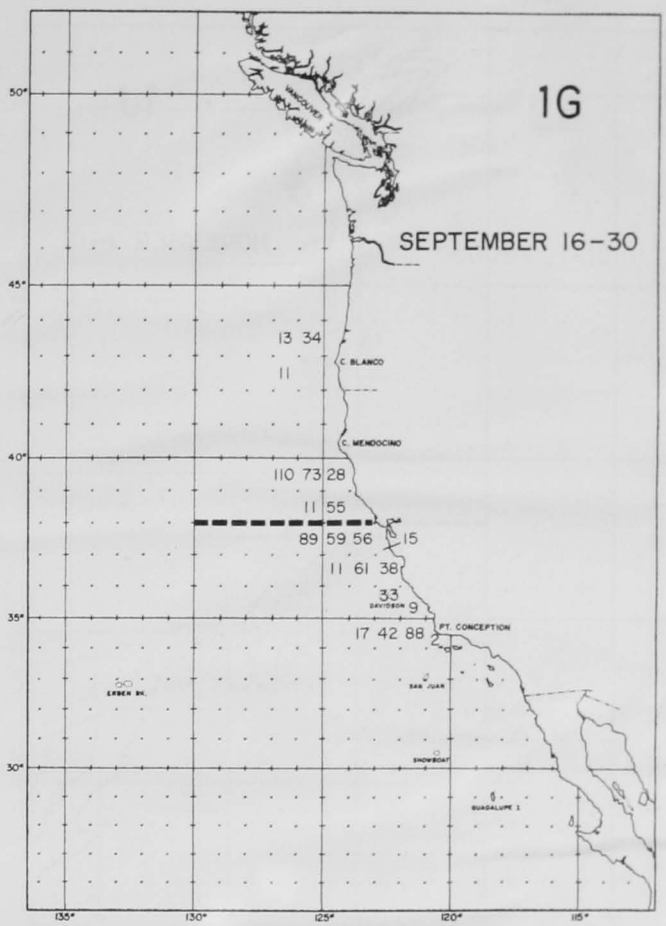

1B
JULY 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
2
92 14 4
200 167 10 33 62
88 88 50 108 77
56 101 76 83 50 77 48
192 150 123 144 64 16
72 99

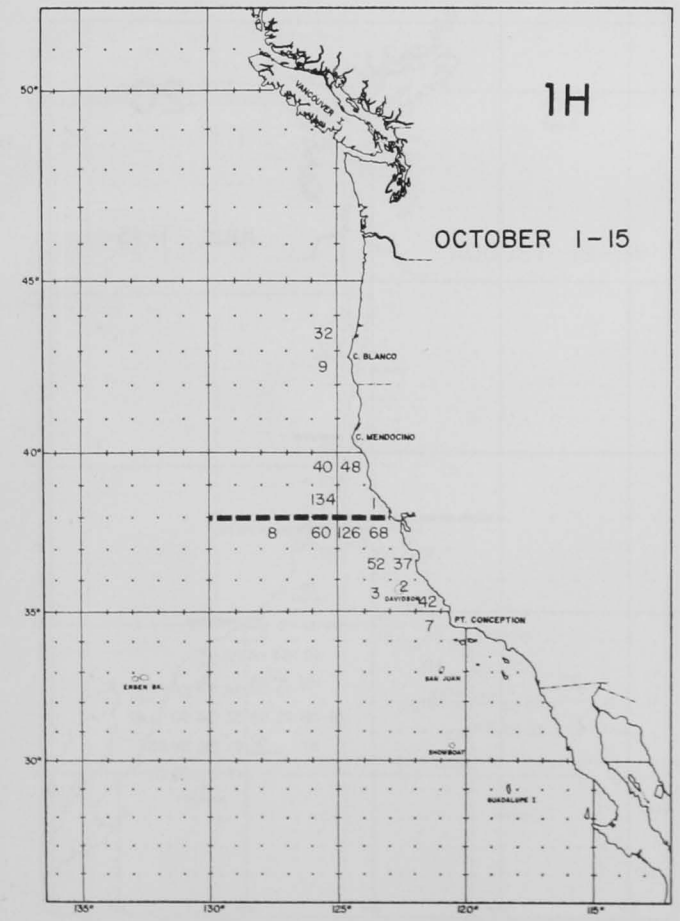

1C
JULY 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
45
90 91
12 49 48 63
2 28 66 76 30
58 81 47 8 4
73 7 53 69 37 35 33
53 92 69 52 55 28 4
38 24 59 9 10
20
2

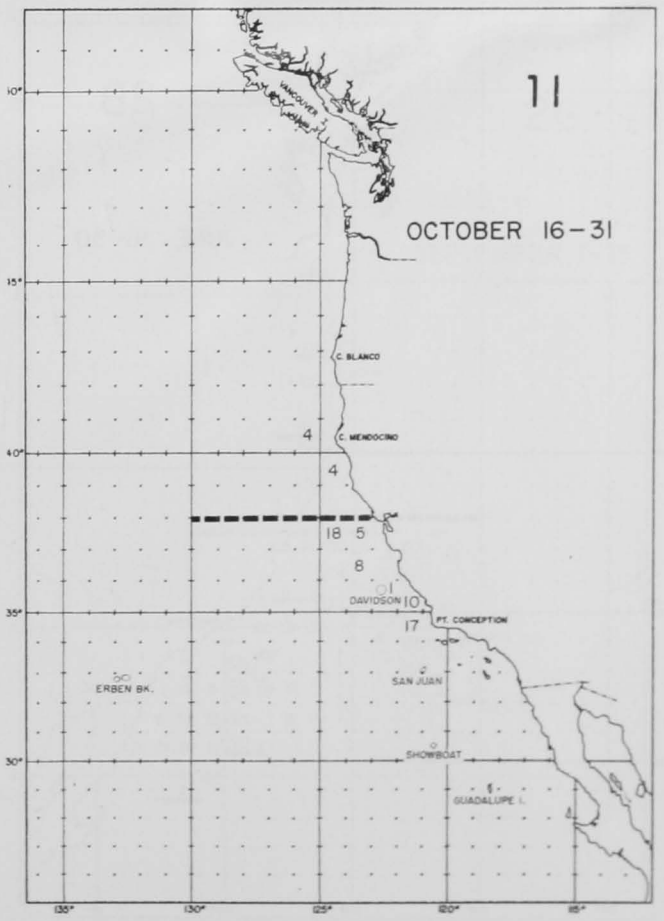

1D
AUGUST 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
80
121
21 37
106 48 75 88
76 105 74 54
56 56 43
42 59 47 9
9 48 31 6
38 39
42 6

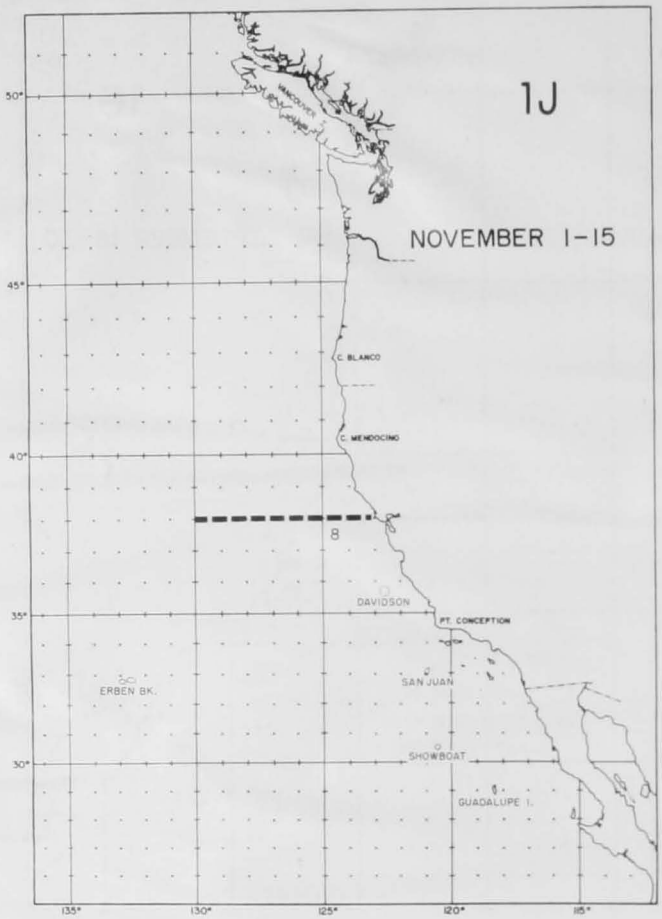

1E
AUGUST 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
251
147
169 150
16
181 63
129 46 66
65 78
118 43 14
70 21 3
9
36 24
23


1F
SEPTEMBER 1-15
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
51
58
159 25
50 154
130 91
16
95 54
90 72
82 42


1G
SEPTEMBER 16-30
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
13 34
11
110 73 28
11 55
89 59 56
15
11 61 38
33
9
17 42 88


1H
OCTOBER 1-15
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
32
9
40 48
134
8 60 126 68
52 37
3 2
42
7


1I
OCTOBER 16-31
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
4
4
18 5
8
1
10
17



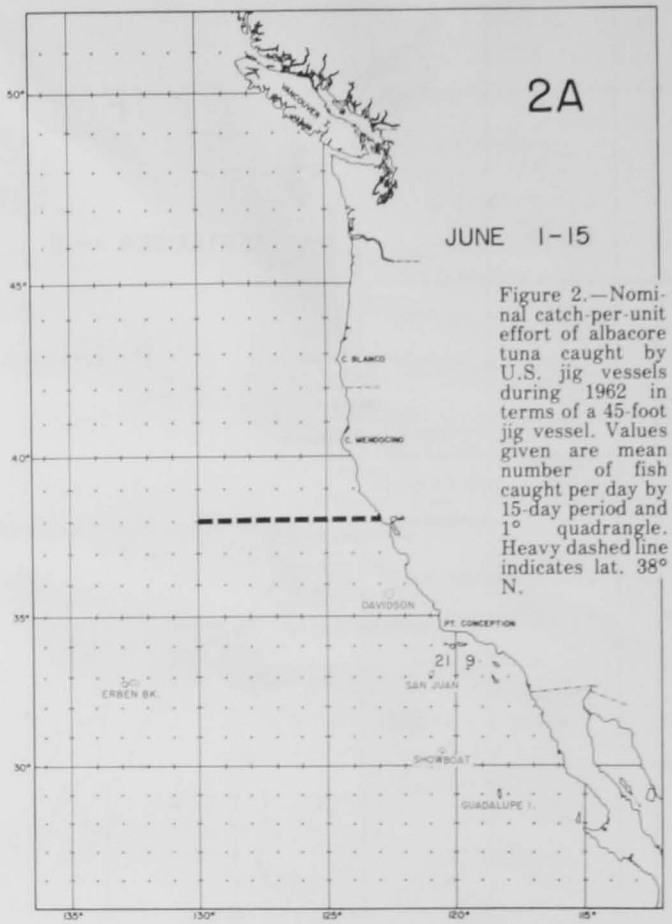
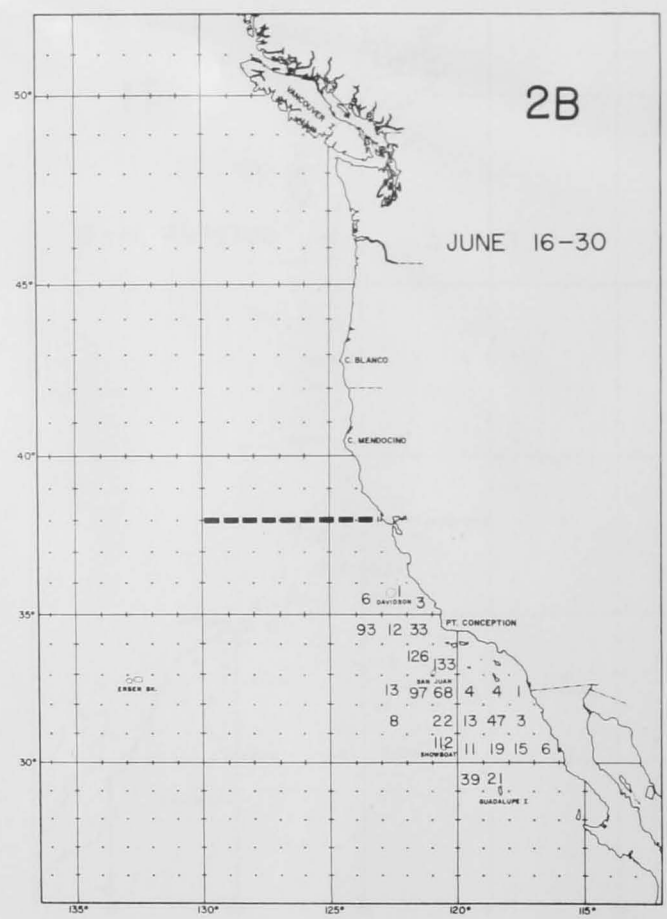
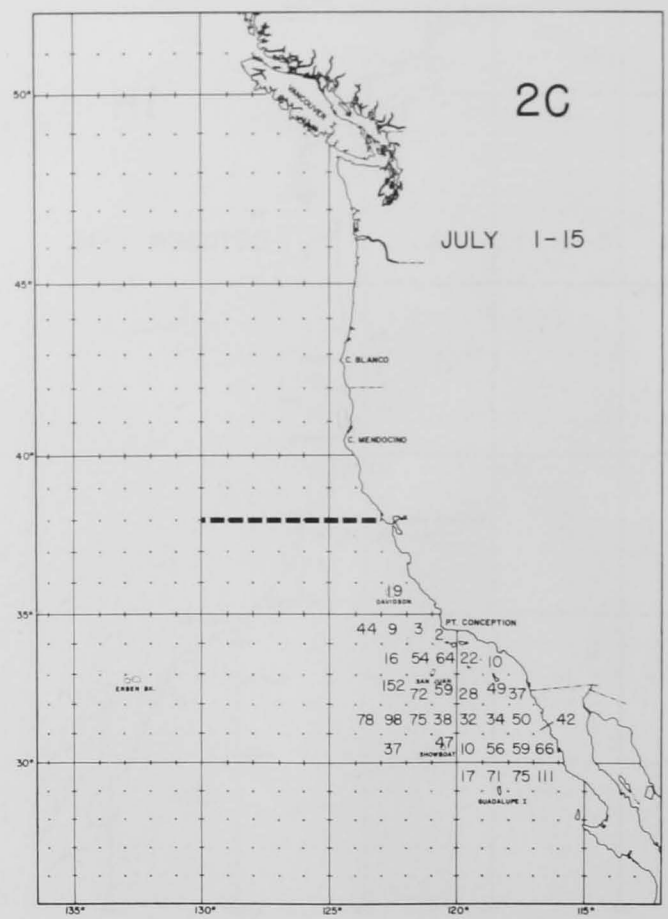
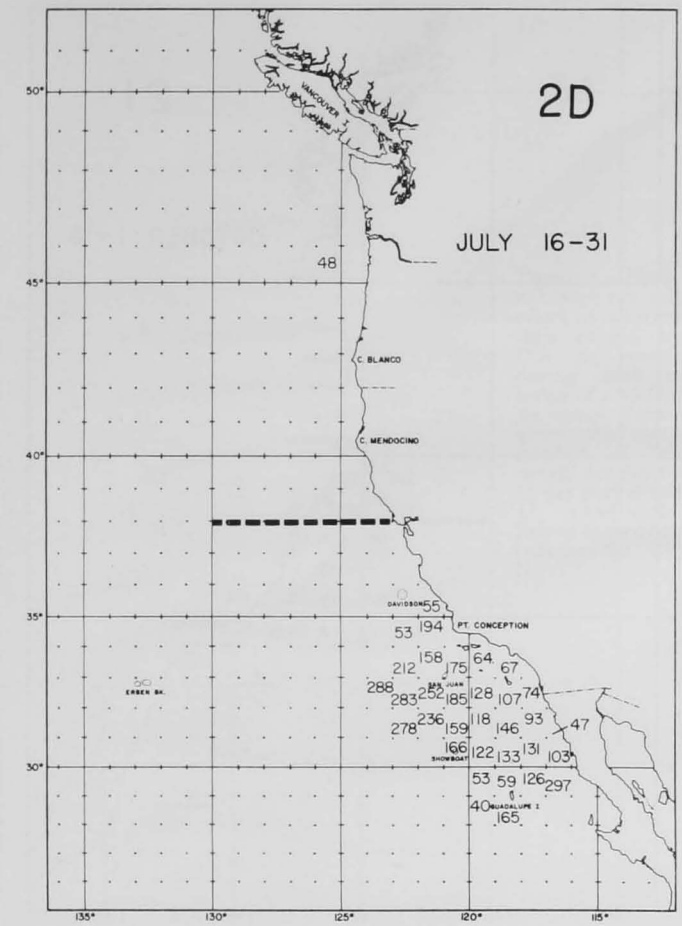
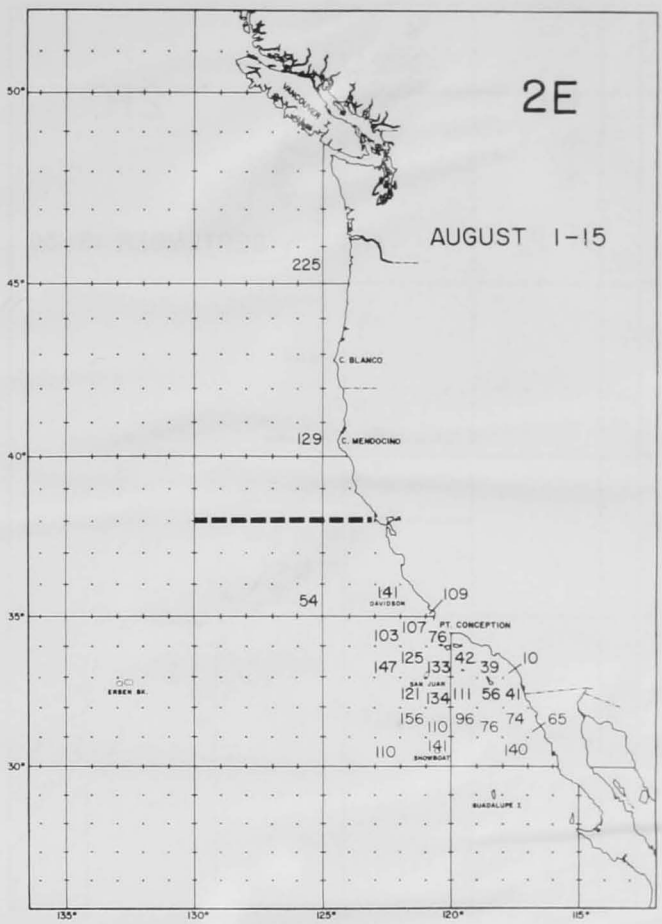


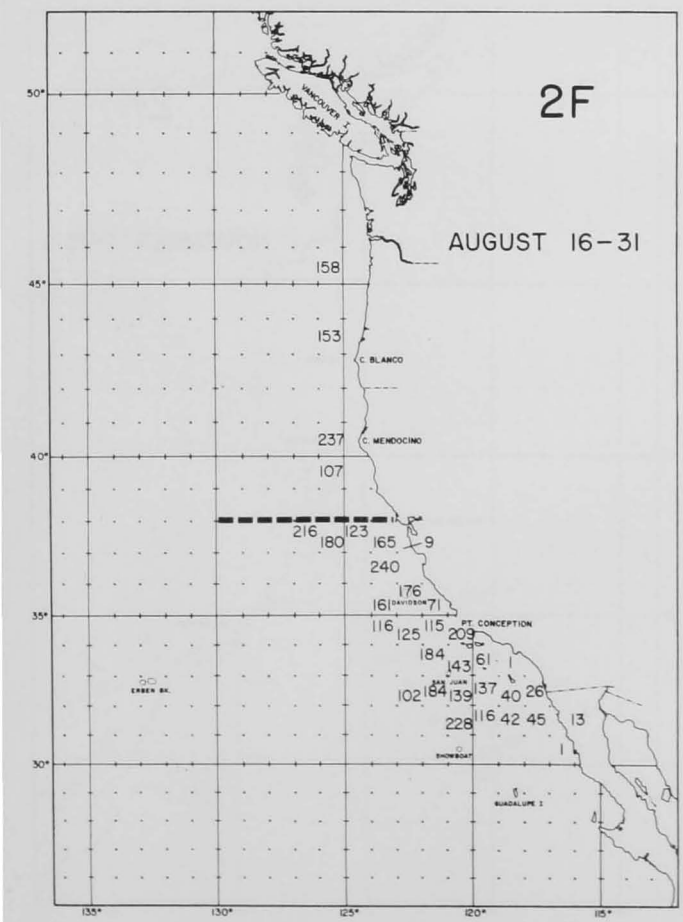
Figure 2.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1962 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

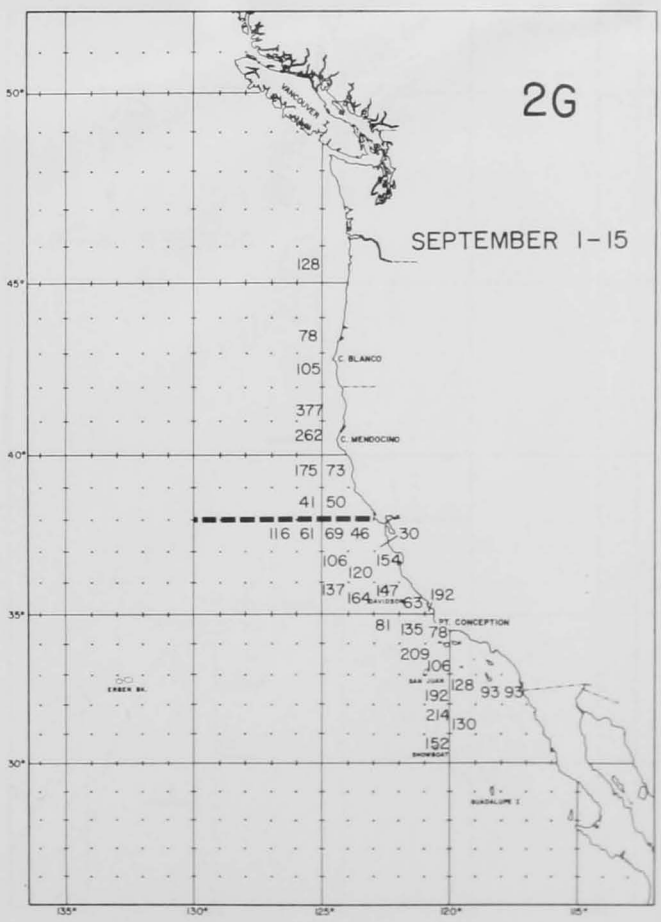


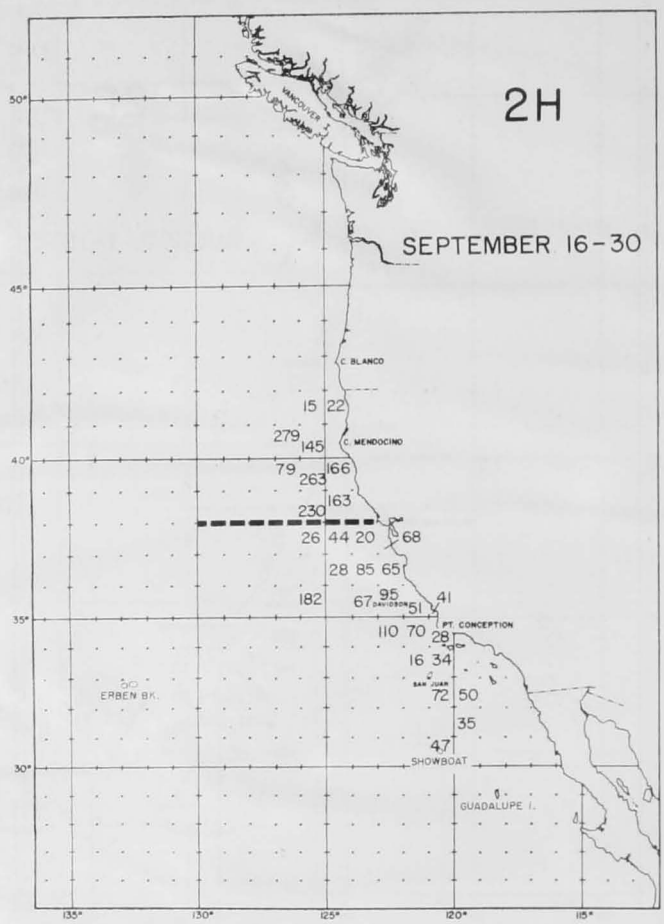


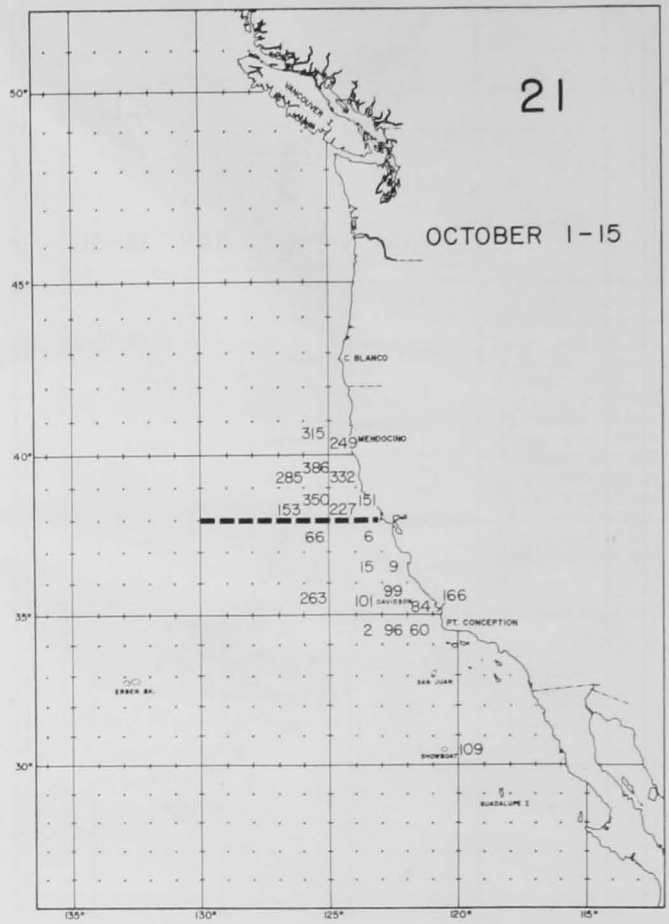

2D
JULY 16-31
48
C. BLANCO
C. MENDOCINO
DAVIDSON
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
55
53 194
212 158 175 64 67
288 283 252 185 128 107 74
278 236 159 118 146 93 47
166 122 133 131 103
53 59 126 297
40 165
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

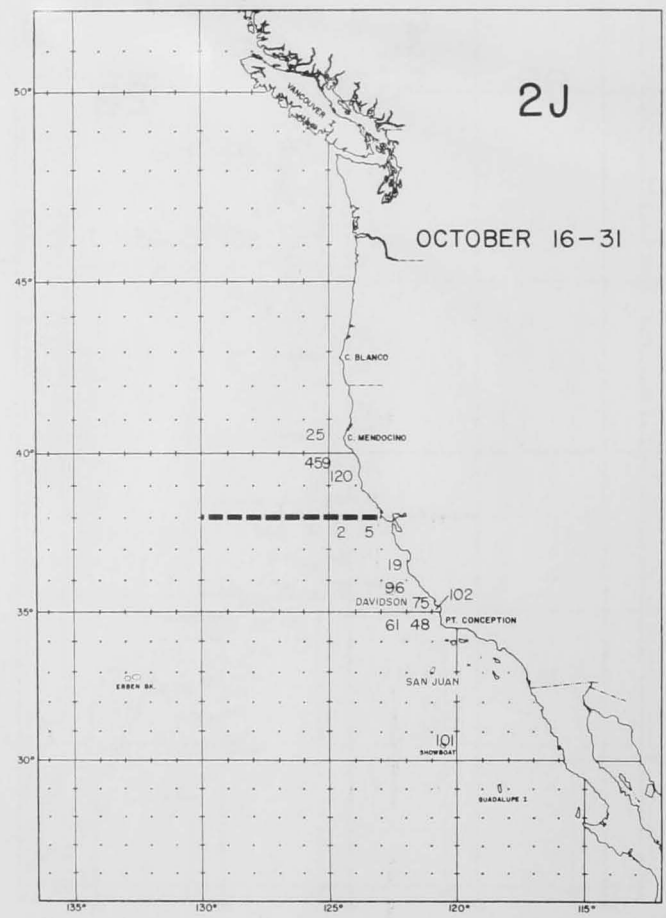

2E
AUGUST 1-15
225
C. BLANCO
C. MENDOCINO
129
DAVIDSON
PT. CONCEPTION
54
141
109
103 107 76
147 125 133 42 39 10
121 134 111 56 41
156 110 96 76 74 65
110 141 140
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

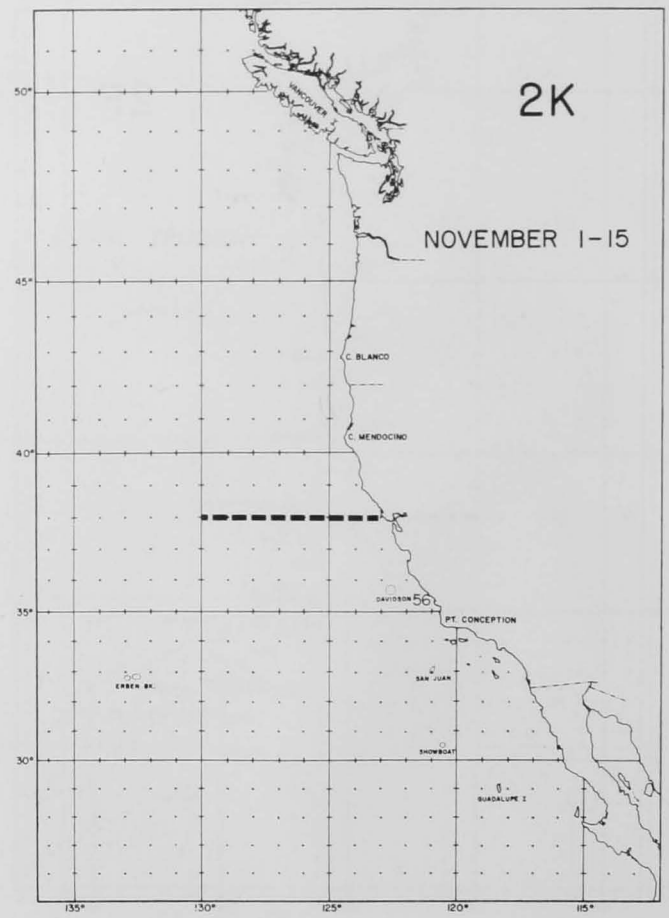

2F
AUGUST 16-31
158
153
C. BLANCO
237
C. MENDOCINO
107
216 180 123 165 9
240
176
161 DAVIDSON 71
116 125 115 209 61 1
184 143
102 184 139 137 40 26
228 116 42 45 13
1
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

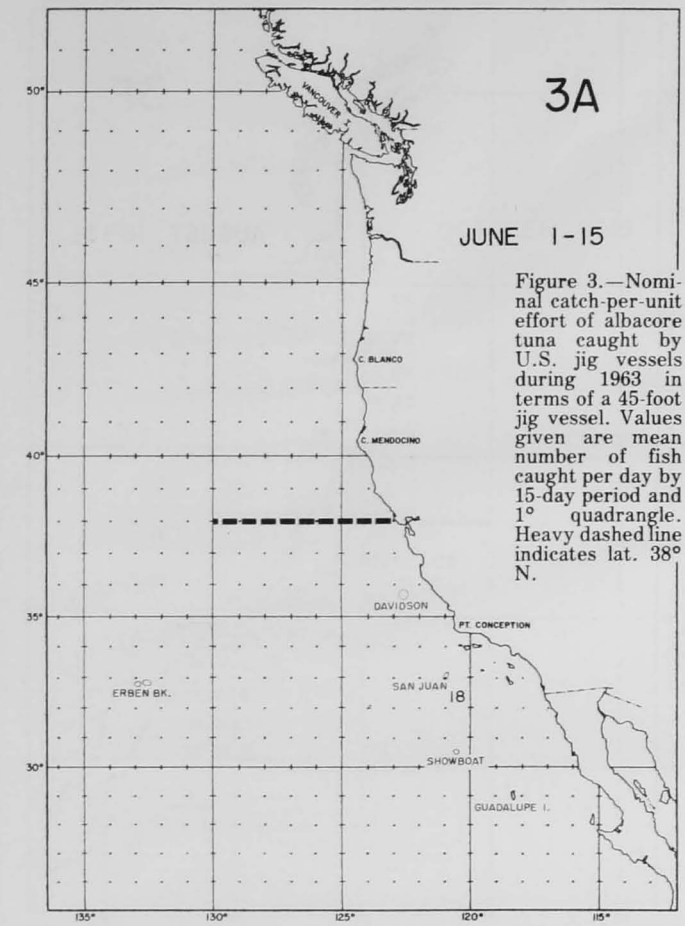

2G
SEPTEMBER 1-15
128
78
105
C. BLANCO
377
262
C. MENDOCINO
175 73
41 50
116 61 69 46 30
106 120 154
137 164 147 63 192
81 135 78
209 106
192 128 93 93
214 130
152
DAVIDSON
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

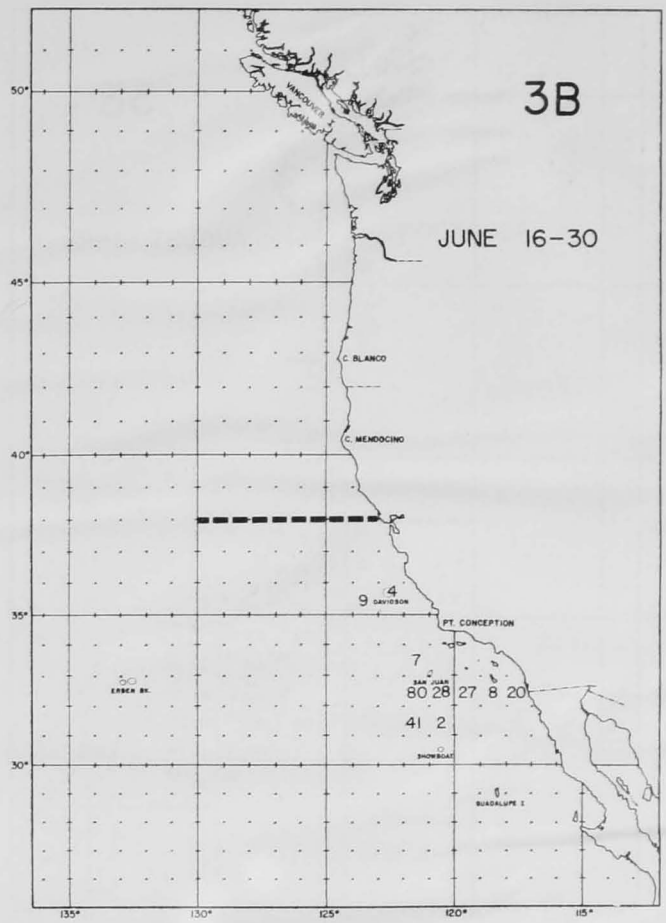

2H
SEPTEMBER 16-30
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
15 22
279 145
79 263 166
163
230
26 44 20 68
28 85 65
182 67 95 51 41
110 70 28
16 34
72 50
35
47

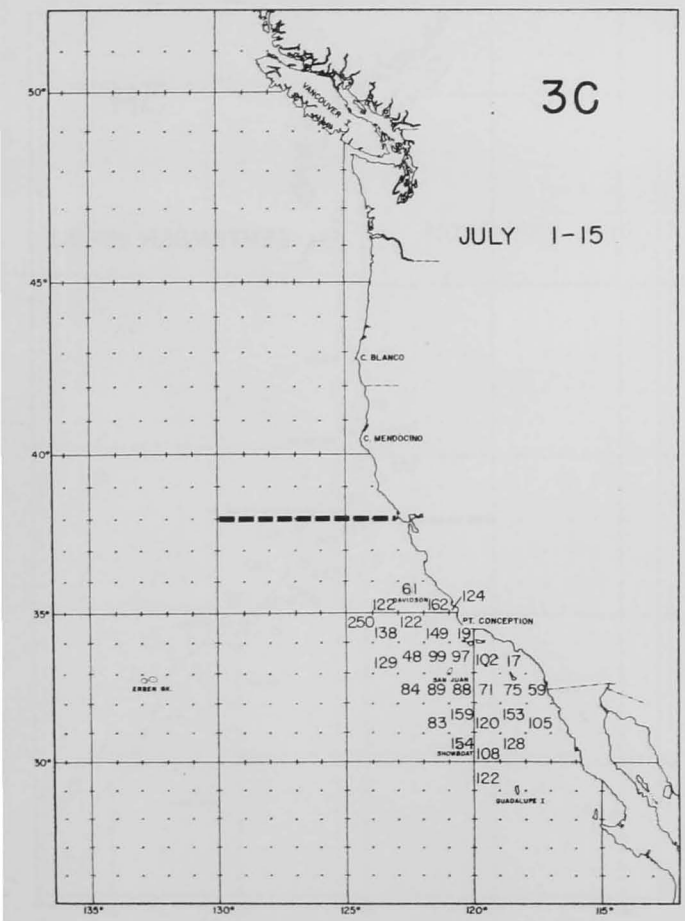

21
OCTOBER 1-15
VANCOUVER
C. BLANCO
MENDOCINO
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
315 249
285 386 332
153 350 227 151
66 6
15 9
263 101 99 84 166
2 96 60
109


2J
OCTOBER 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
25
459
120
2 5
19
96
DAVIDSON 75 102
61 48
101


2K
NOVEMBER 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
DAVIDSON 56
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°







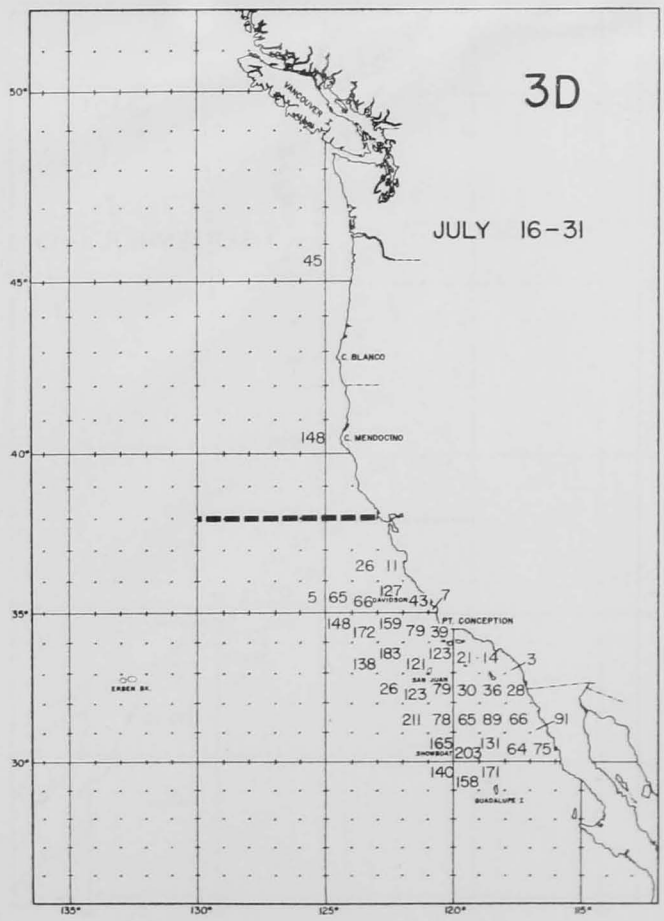
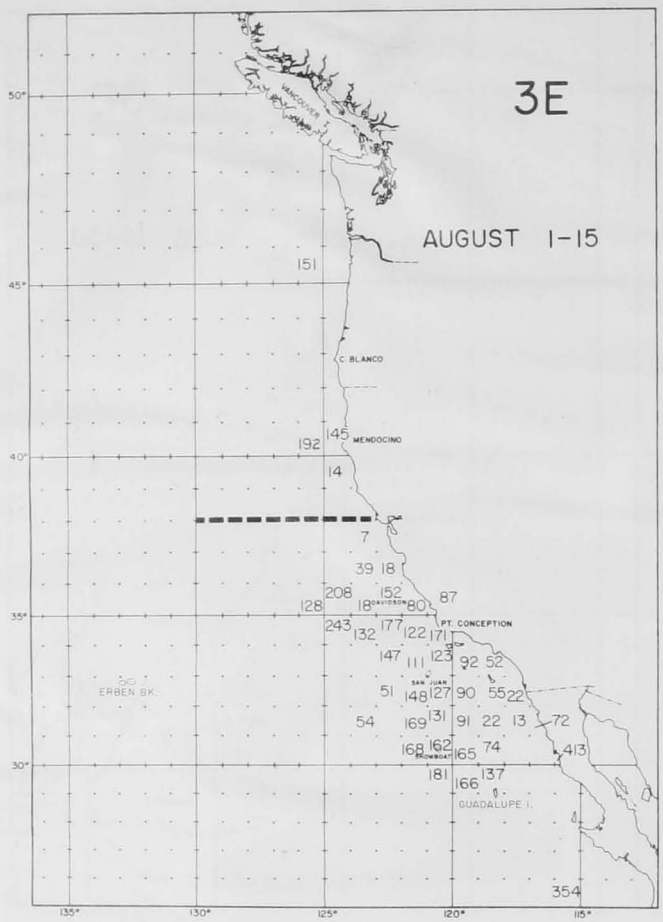
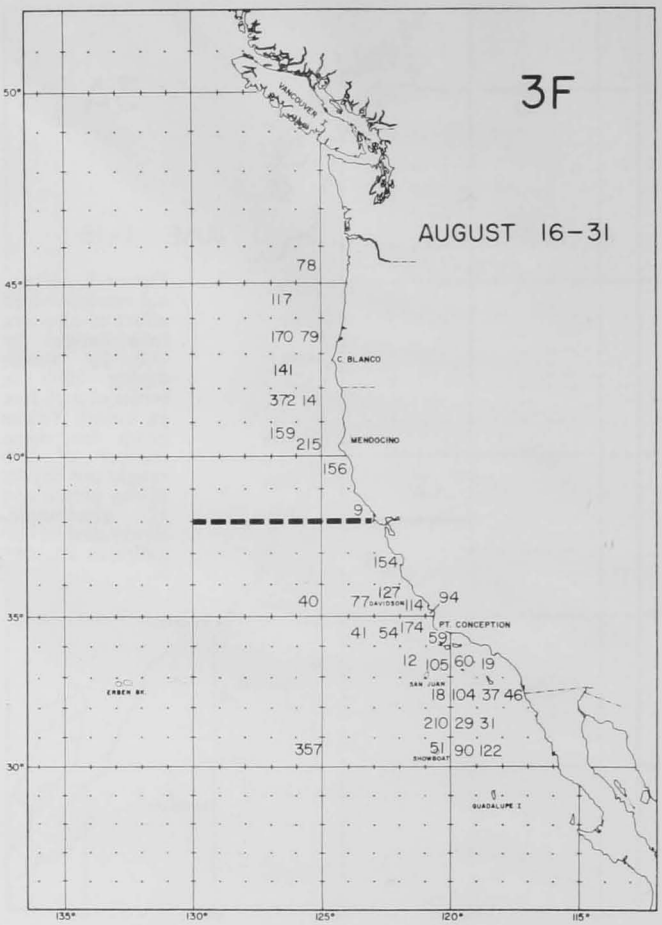
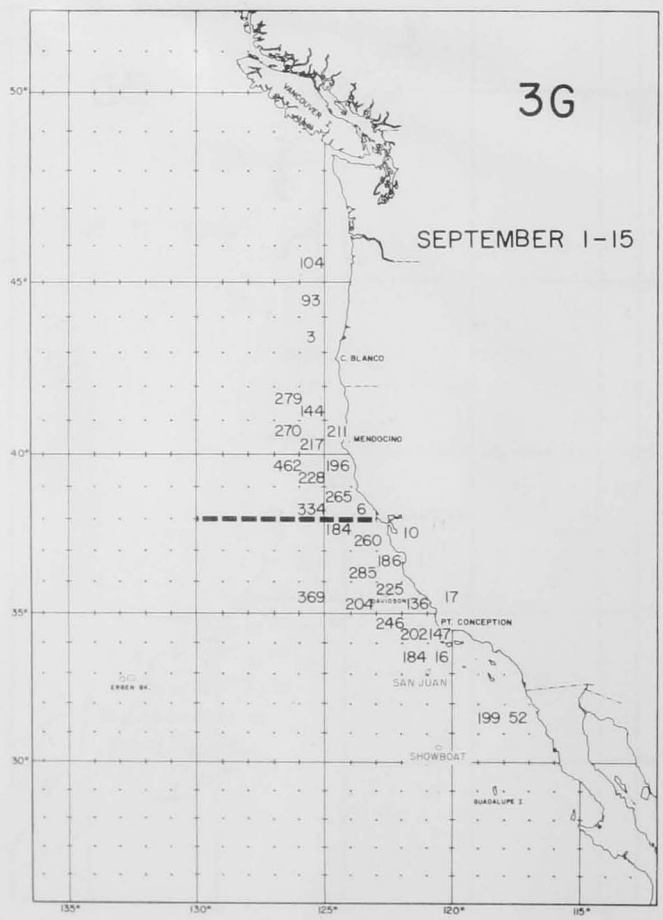
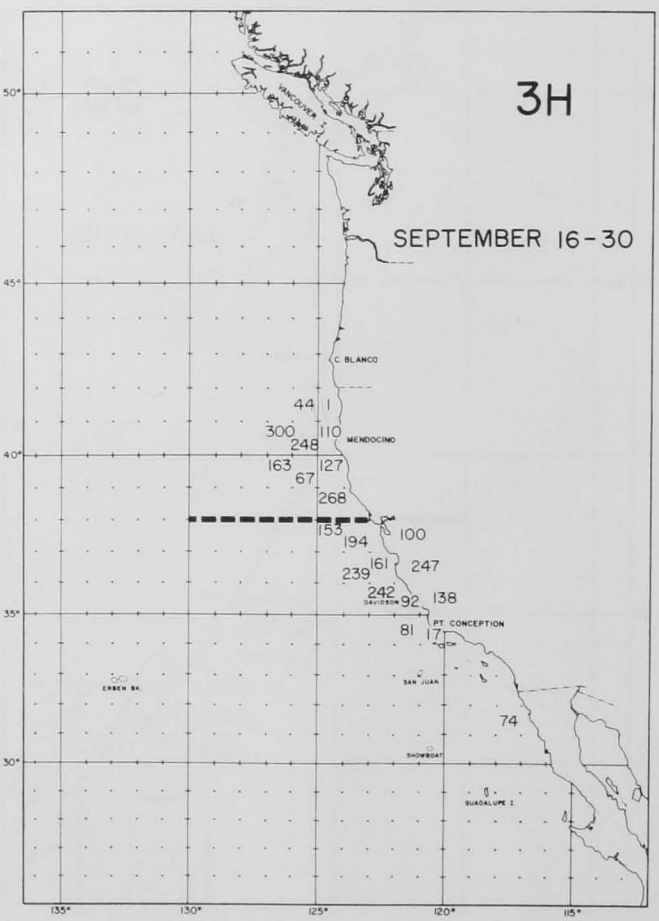


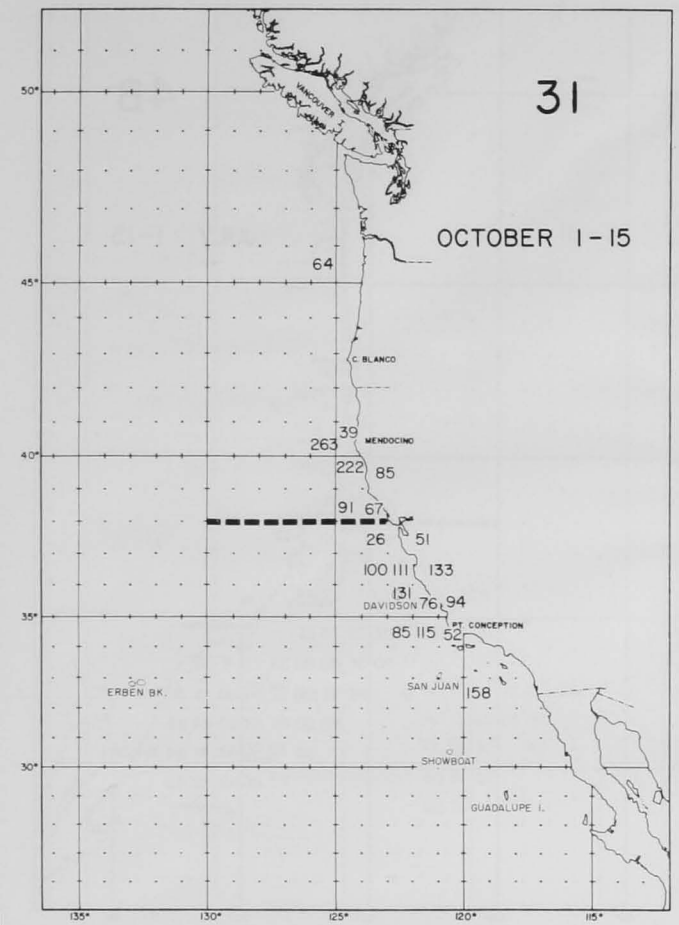
Figure 3.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1963 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

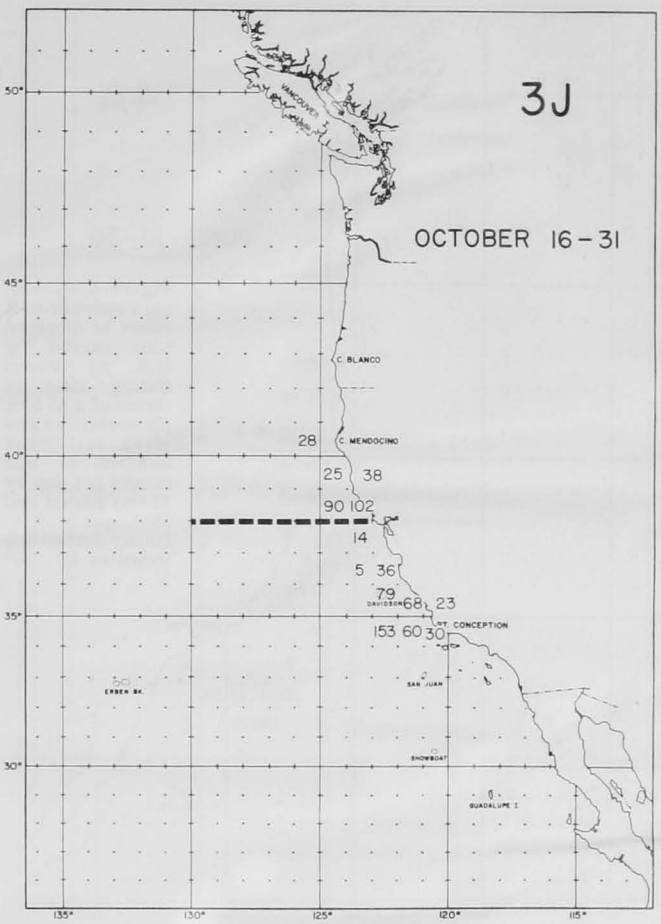

3E
AUGUST 1-15
VANCOUVER
C. BLANCO
MENDOCINO
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
151
192
145
14
7
39
18
208
152
128
18
80
87
243
132
177
122
171
147
111
123
92
52
51
148
127
90
55
22
54
169
131
91
22
13
72
168
162
165
74
413
181
166
137
354

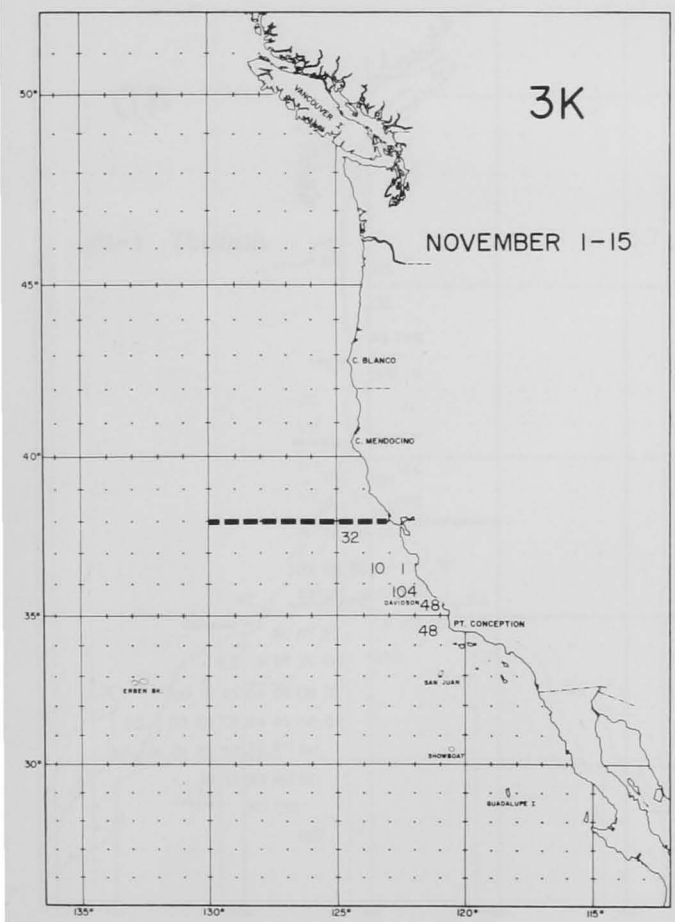

3F
AUGUST 16-31
VANCOUVER
C. BLANCO
MENDOCINO
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
78
117
170
79
141
372
14
159
215
156
9
154
40
77
127
114
94
41
54
174
59
12
105
60
19
18
104
37
46
210
29
31
357
51
90
122

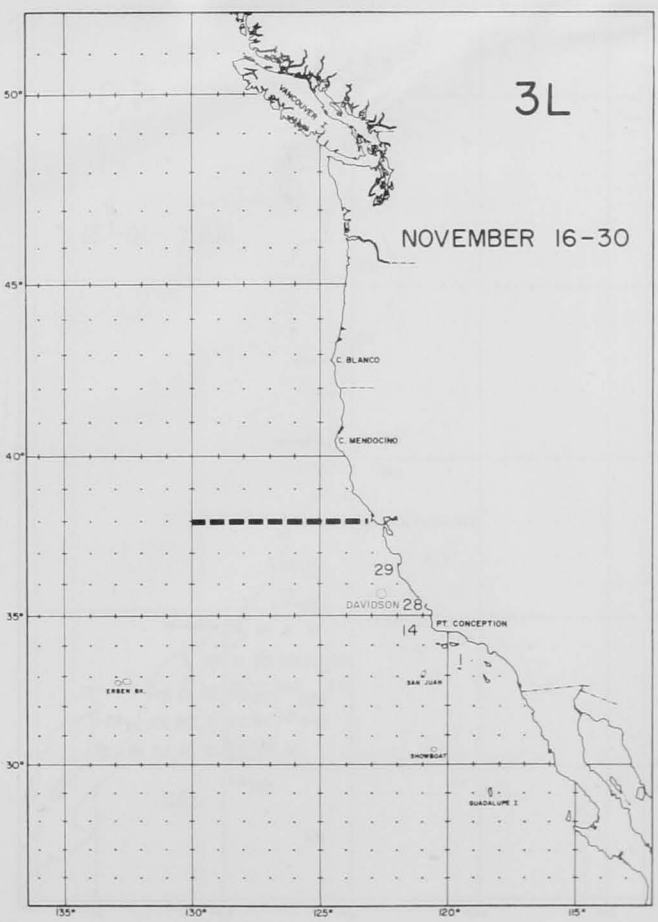

3G
SEPTEMBER 1-15
VANCOUVER
C. BLANCO
MENDOCINO
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
104
93
3
279
144
270
211
217
462
196
228
265
334
6
184
260
10
186
283
225
369
204
136
17
246
202
147
184
16
199
52

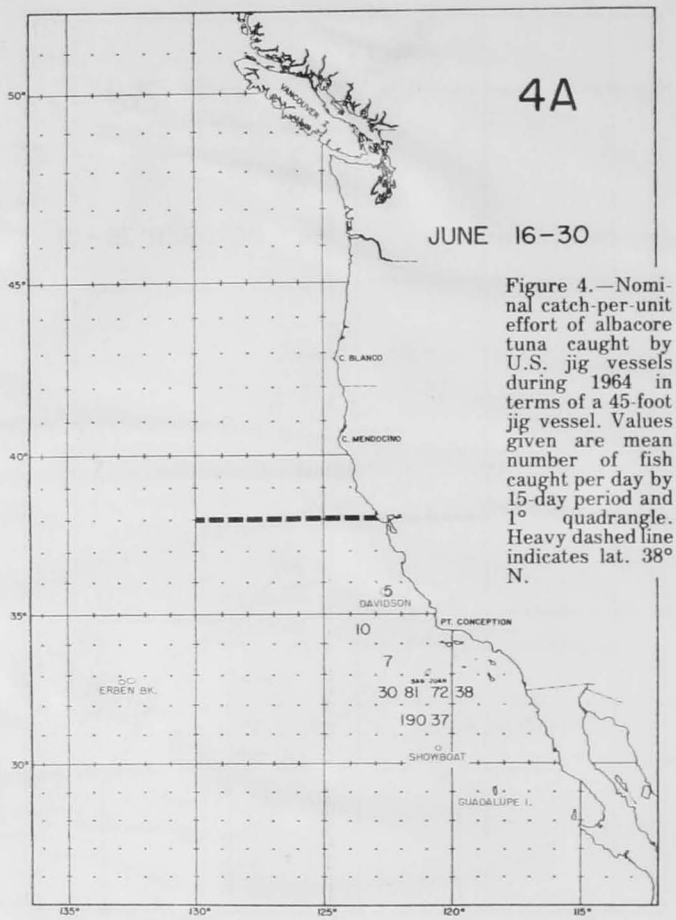

3H
SEPTEMBER 16-30
VANCOUVER
C. BLANCO
MENDOCINO
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
44
1
300
110
248
163
127
67
268
153
194
100
239
161
247
242
92
138
81
17
74

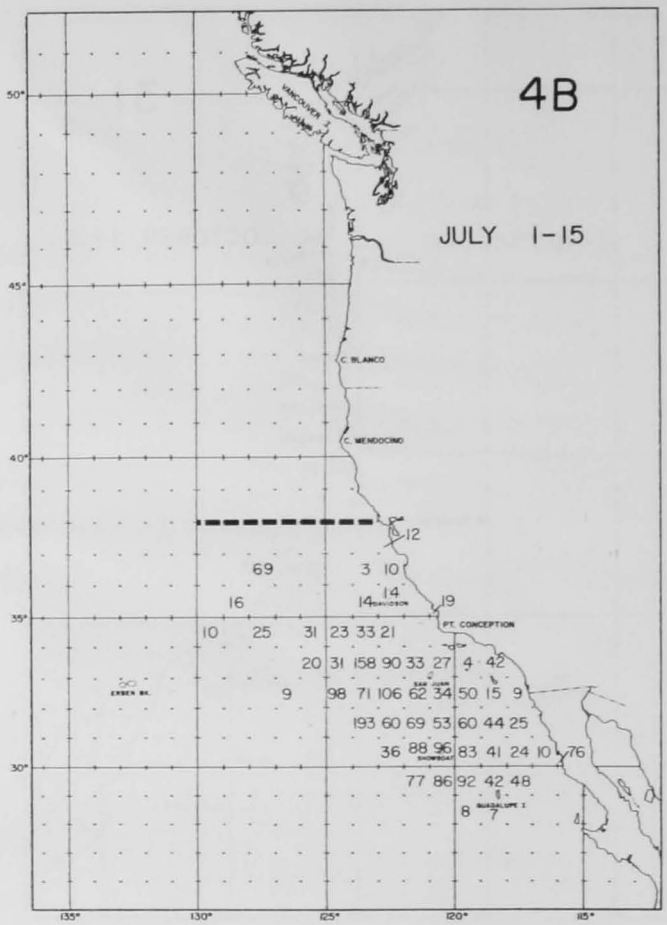

3I
OCTOBER 1-15
64
C. BLANCO
39
263
C. MENDOCINO
222
85
91 67
26
51
100 111
133
131
DAVIDSON 76
94
85 115 52
PT. CONCEPTION
ERBEN BK.
SAN JUAN
158
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

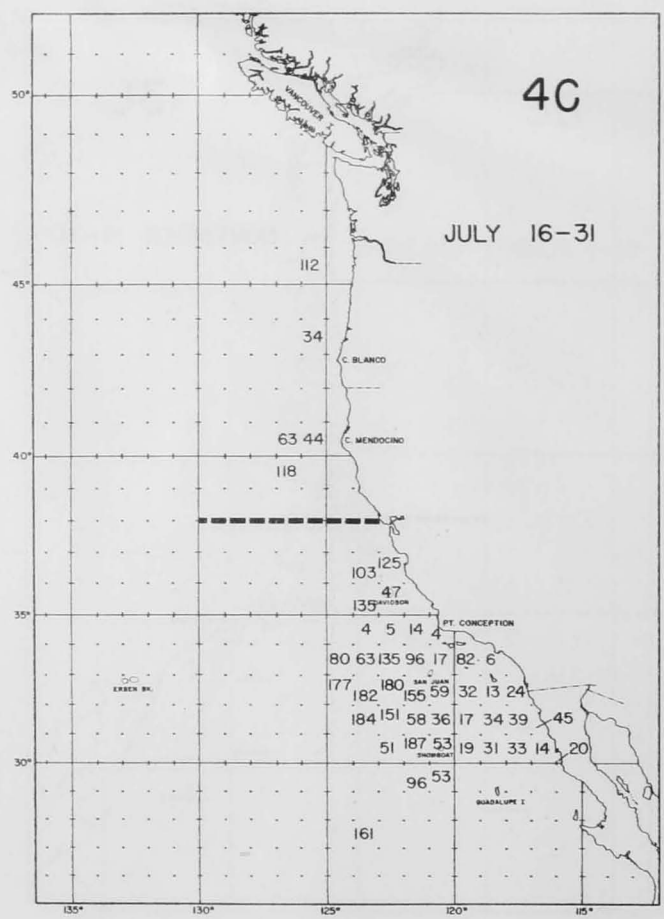

3J
OCTOBER 16-31
C. BLANCO
28
C. MENDOCINO
25
38
90 102
14
5
36
79
DAVIDSON 68
23
153 60 30
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


3K
NOVEMBER 1-15
C. BLANCO
C. MENDOCINO
32
10
1
104
DAVIDSON 48
48
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


3L
NOVEMBER 16-30
C. BLANCO
C. MENDOCINO
29
DAVIDSON 28
14
PT. CONCEPTION
1
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°







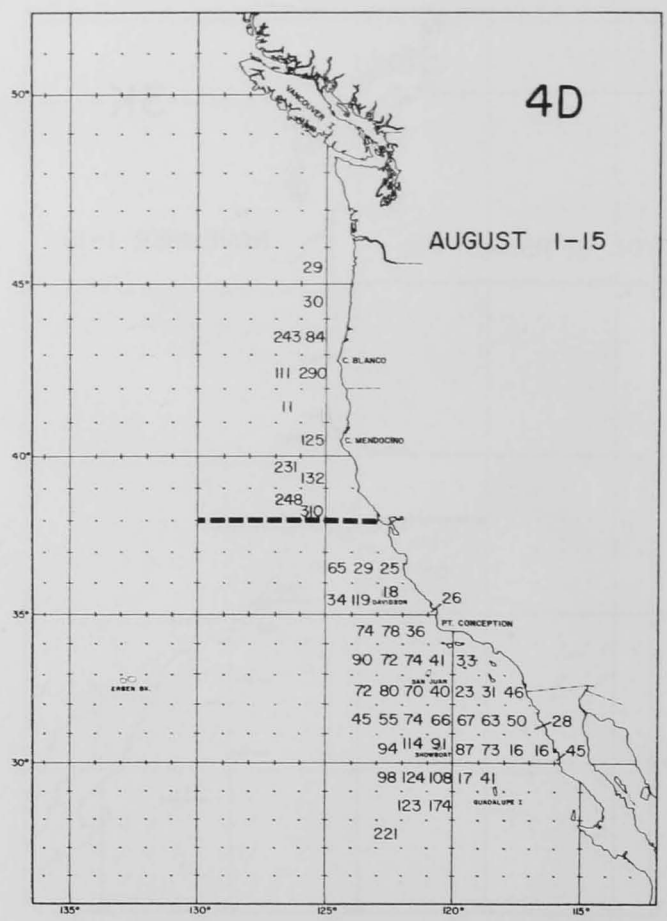
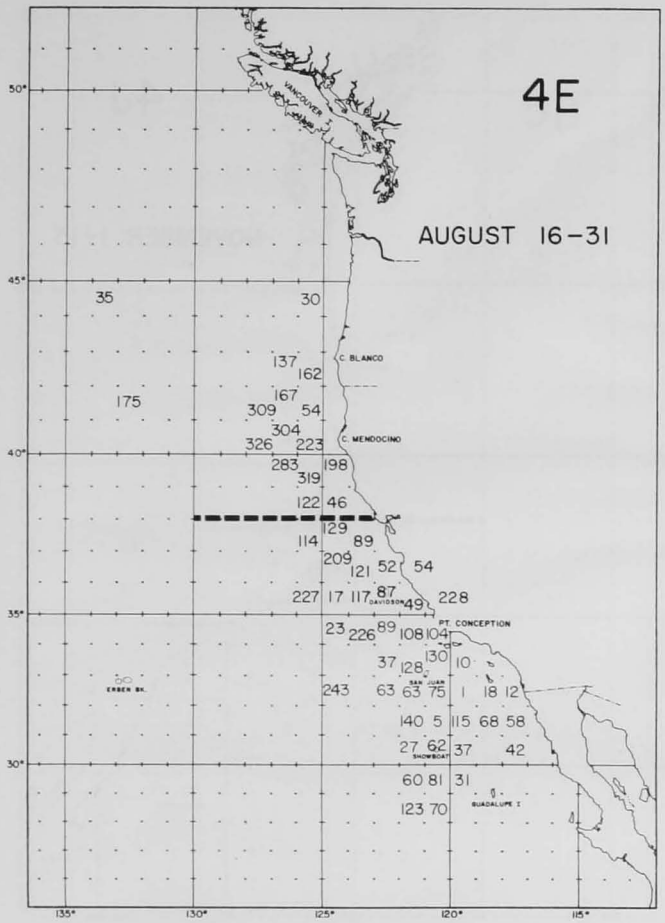
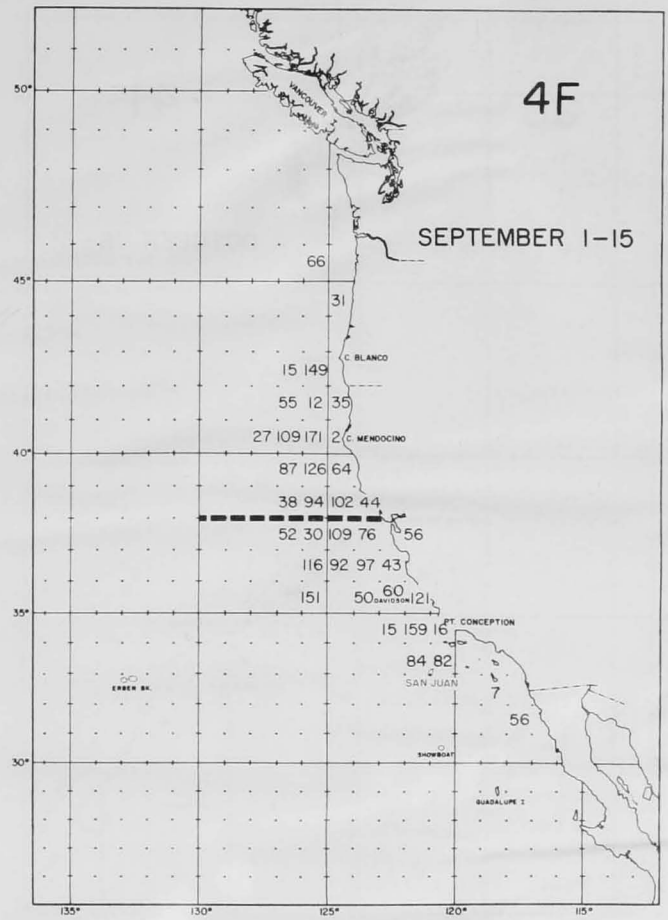
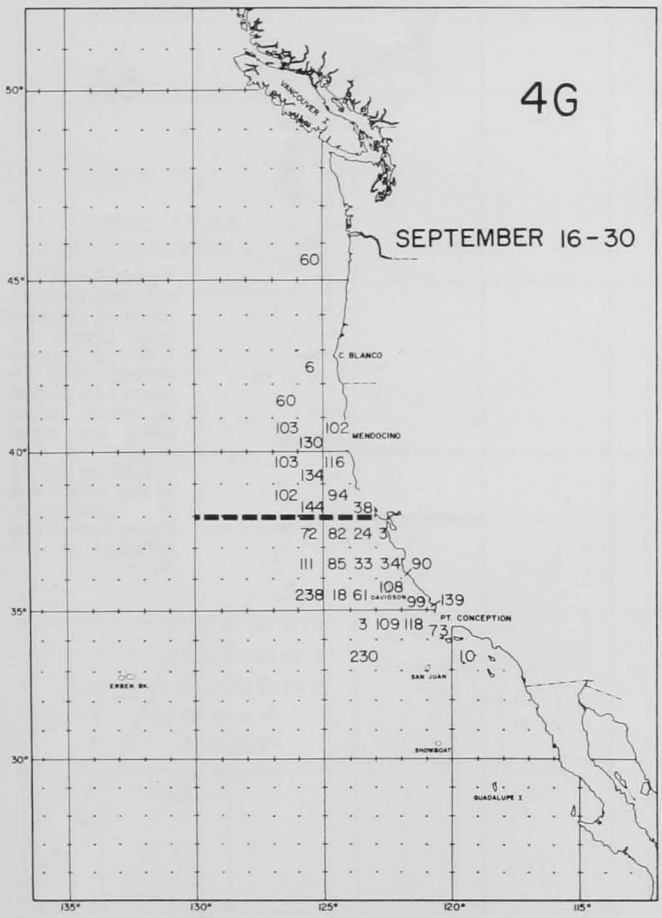
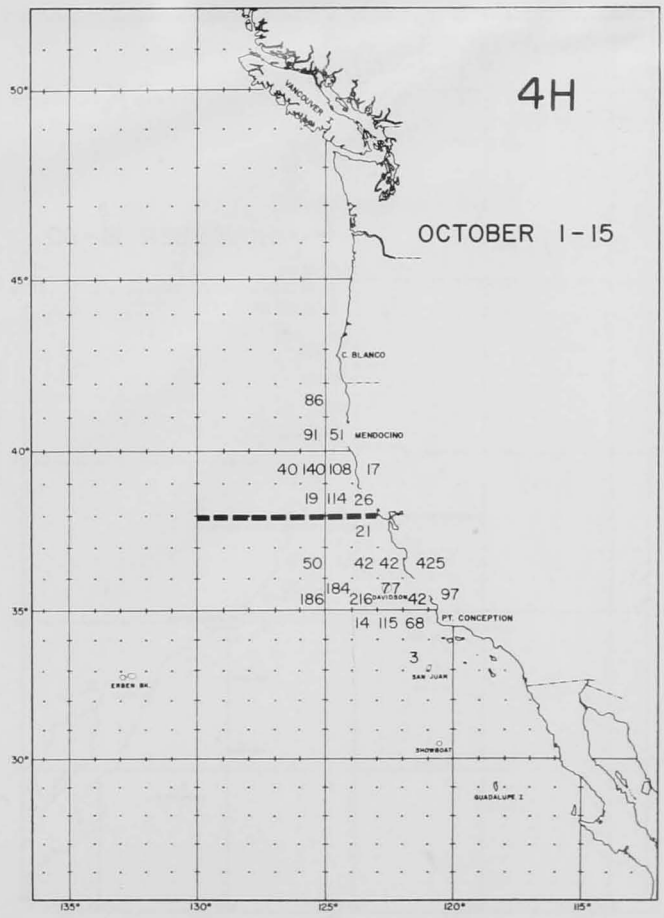


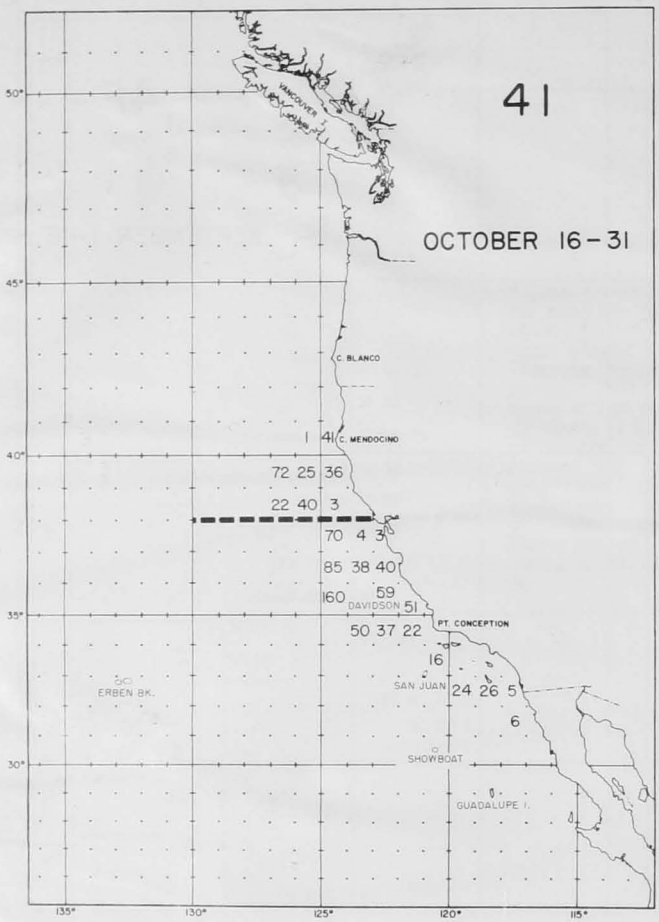
Figure 4.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1964 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

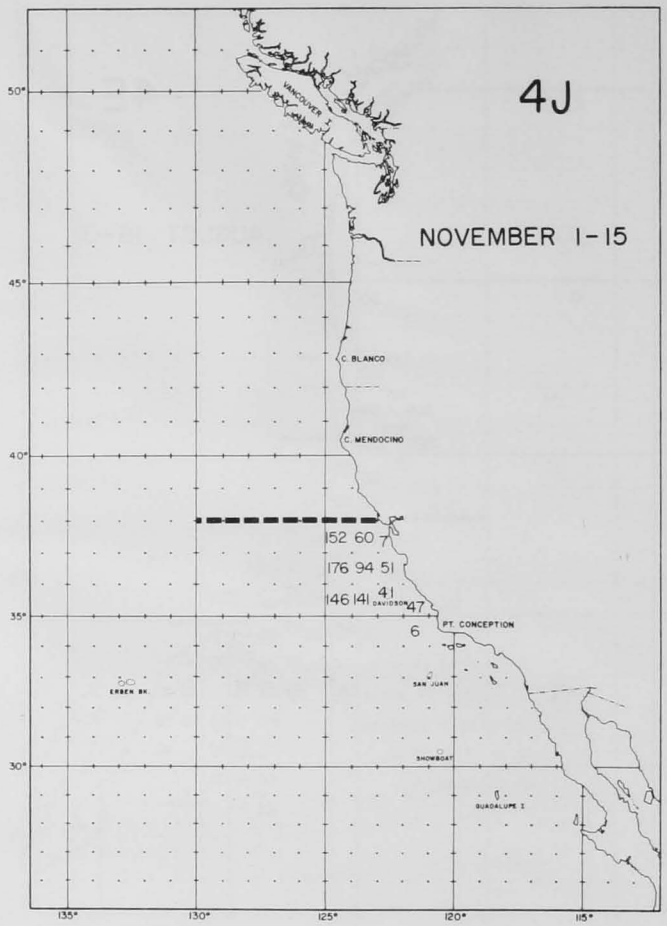

4E
AUGUST 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
35
30
137
162
175
167
309
54
304
326
223
283
198
319
122
46
129
114
89
209
121
52
54
227
17
117
87
49
228
23
226
89
108
104
130
10
37
128
243
63
63
75
1
18
12
140
5
115
68
58
27
62
37
42
60
81
31
123
70

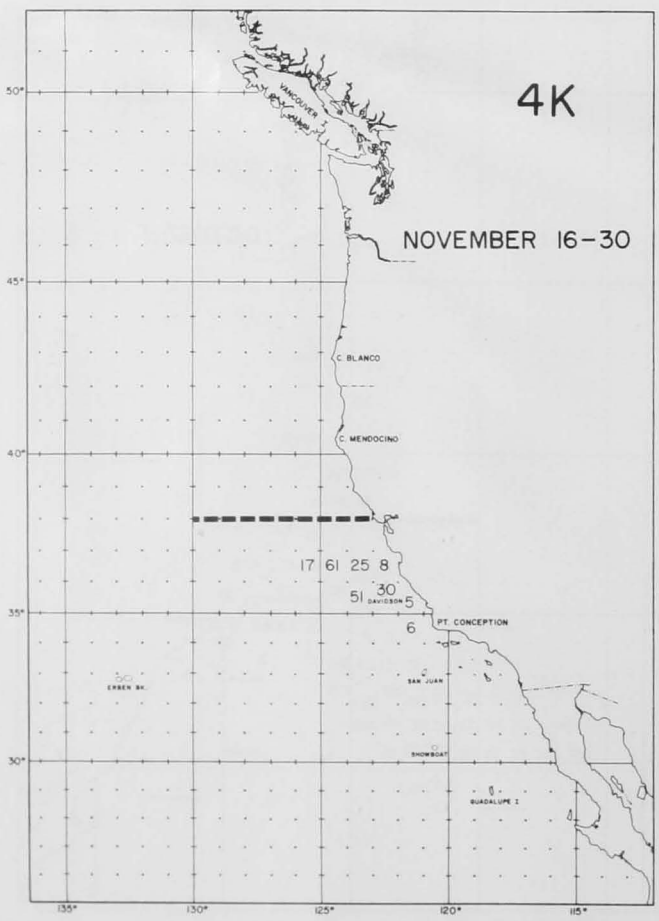

4F
SEPTEMBER 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
66
31
15
149
55
12
35
27
109
171
2
87
126
64
38
94
102
44
52
30
109
76
56
116
92
97
43
151
50
60
121
15
159
16
84
82
7
56


4G
SEPTEMBER 16-30
VANCOUVER
C. BLANCO
MENDOCINO
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
60
6
60
103
102
130
103
116
134
102
94
144
38
72
82
24
3
111
85
33
34
90
108
238
18
61
99
139
3
109
118
73
230
10


4H
OCTOBER 1-15
VANCOUVER
C. BLANCO
MENDOCINO
PT. CONCEPTION
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°
86
91
51
40
140
108
17
19
114
26
21
50
42
42
425
184
77
186
216
42
97
14
115
68
3







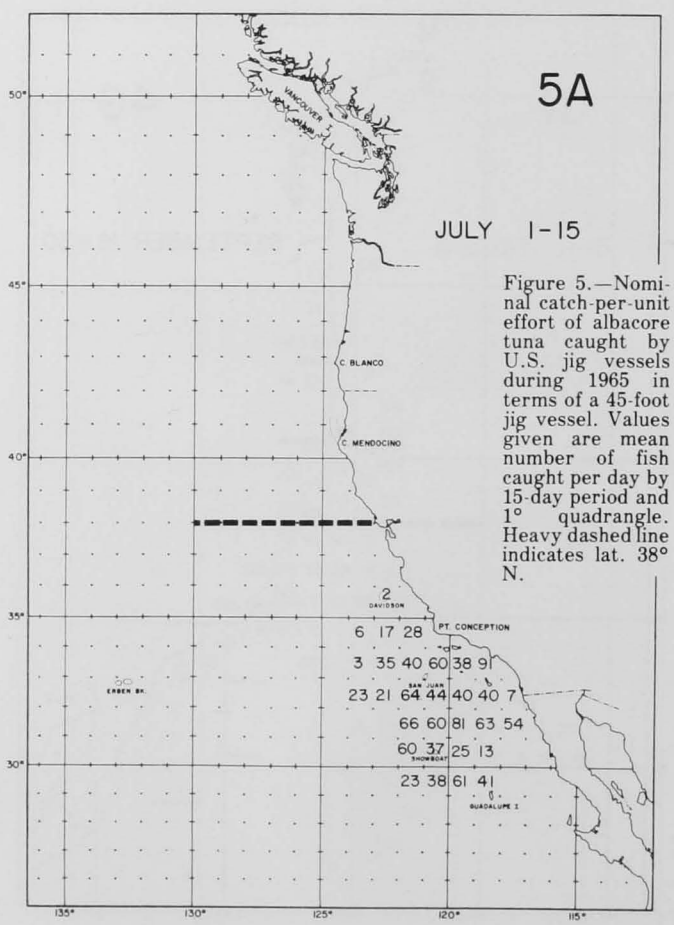
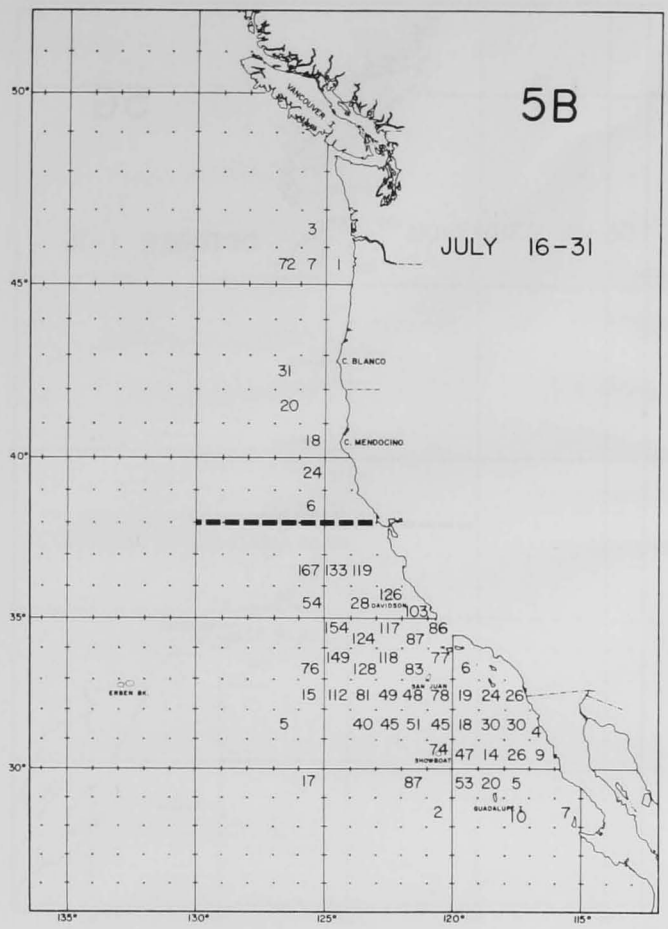
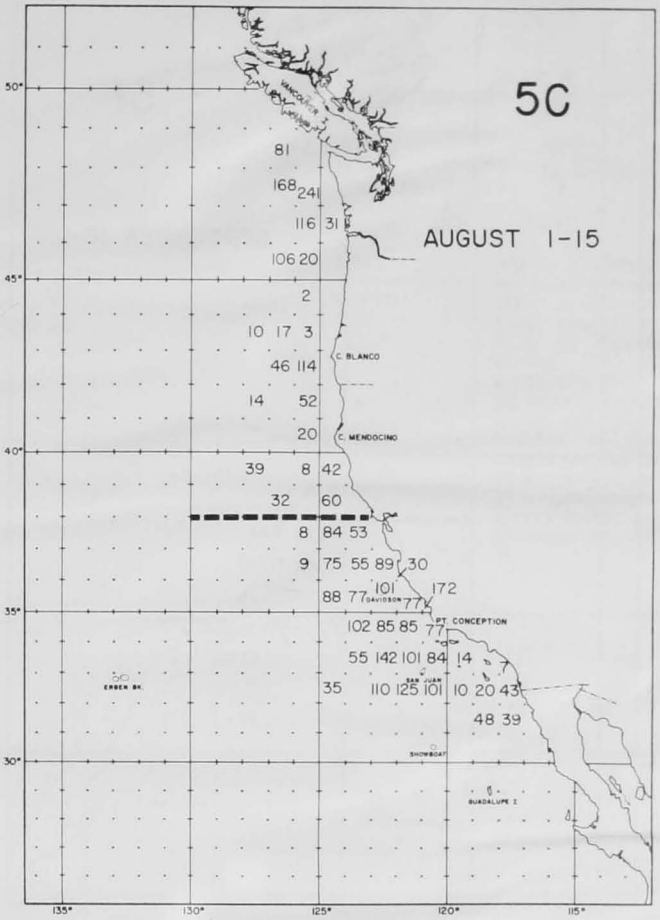
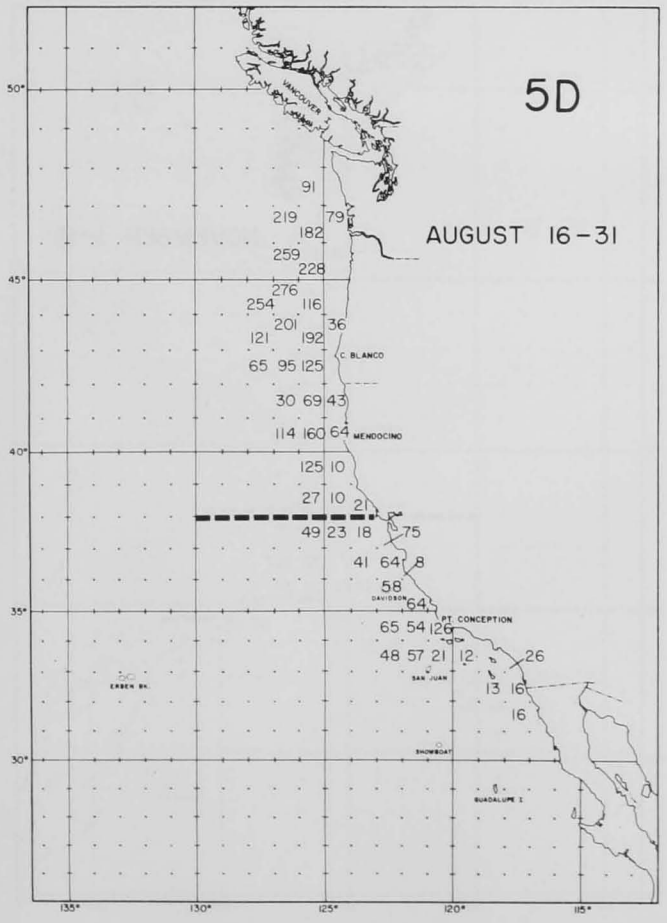
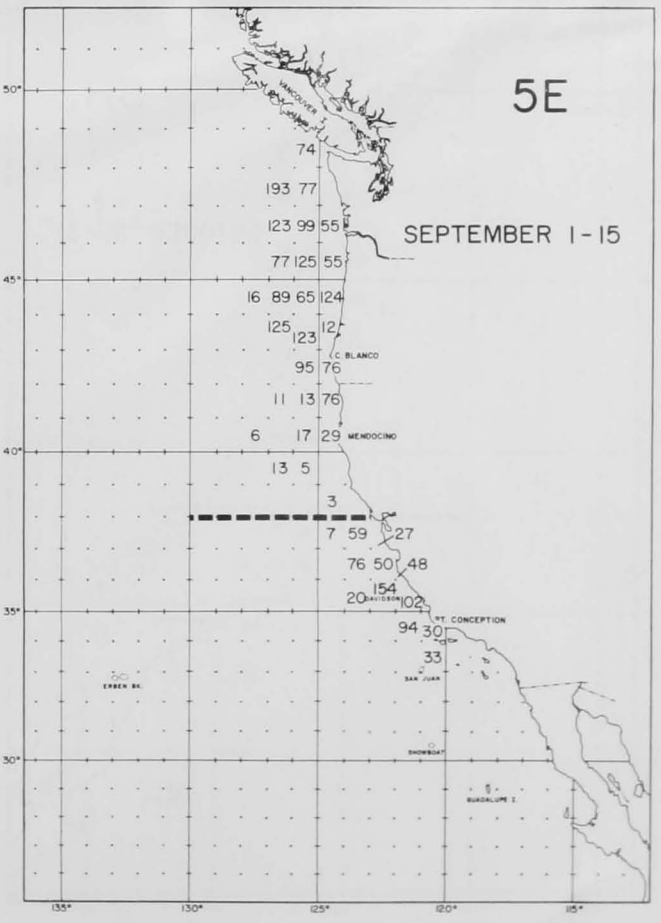


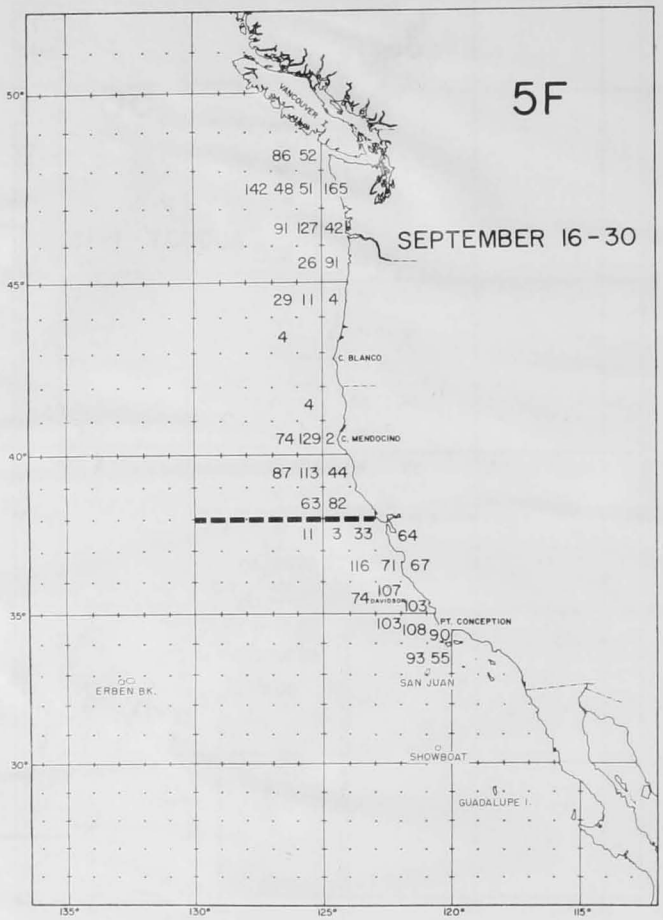
Figure 5.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1965 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

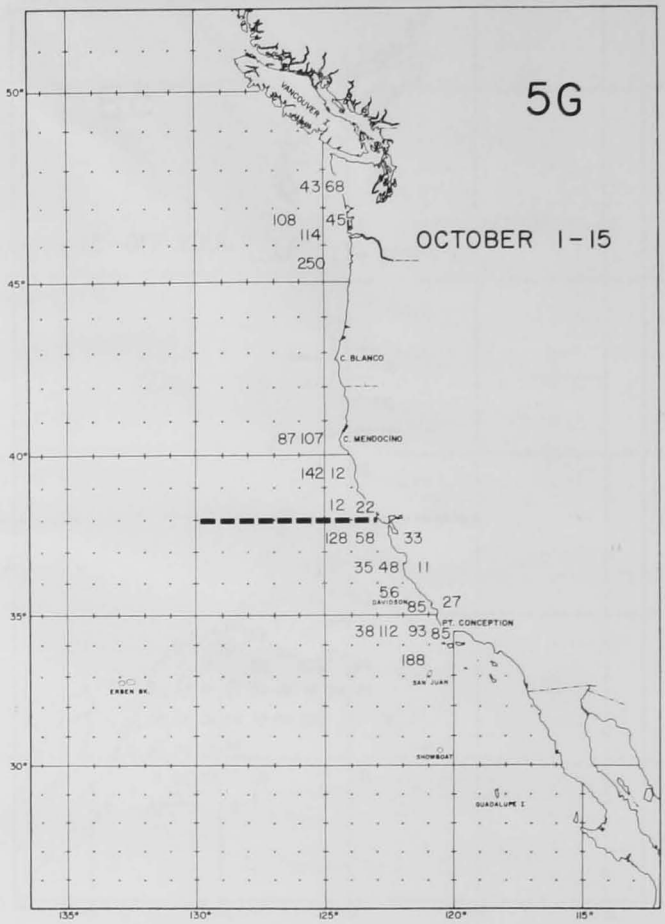

5B
JULY 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

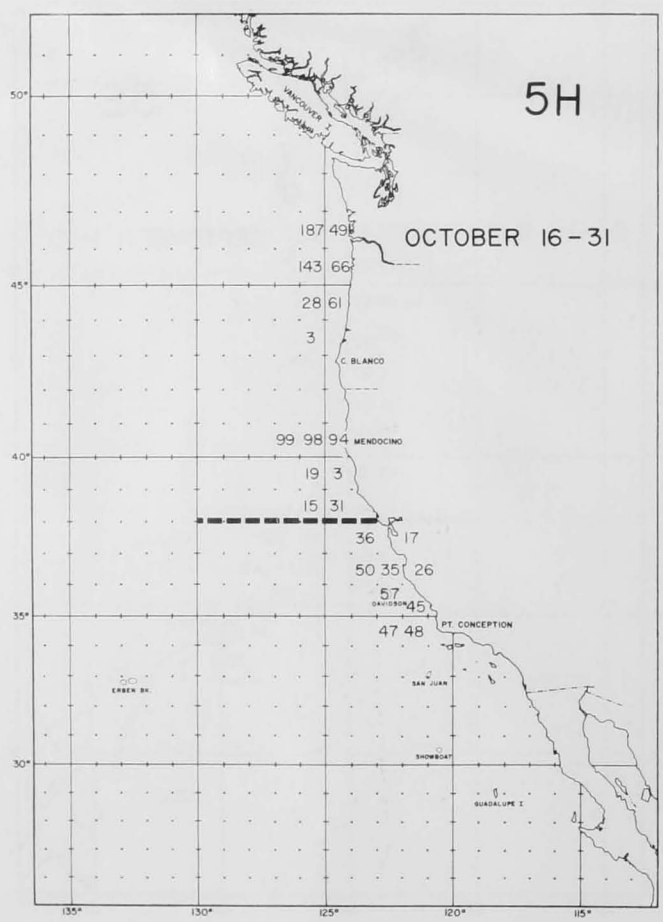

5C
AUGUST 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

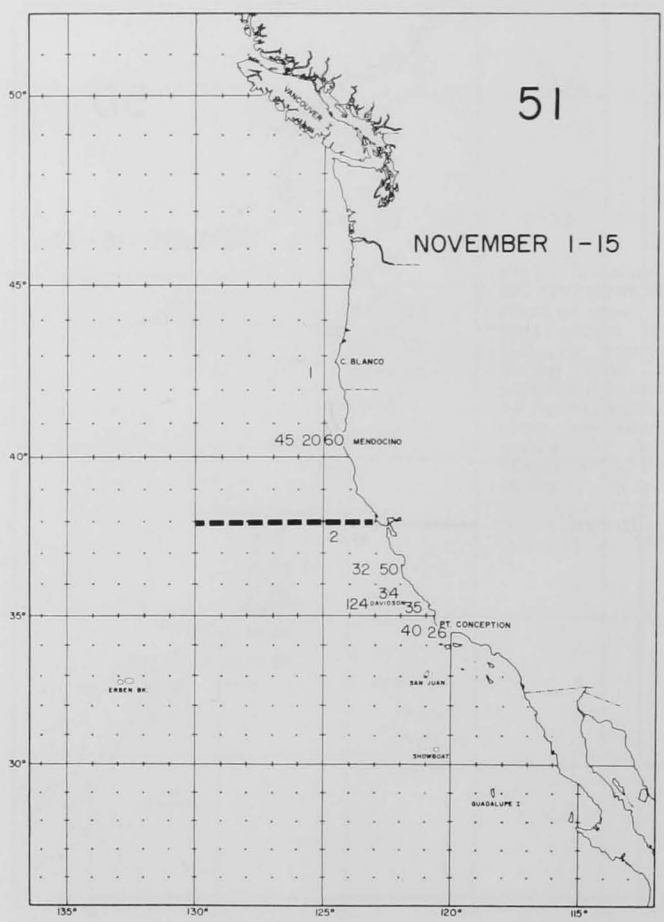

5D
AUGUST 16-31
VANCOUVER
C. BLANCO
MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

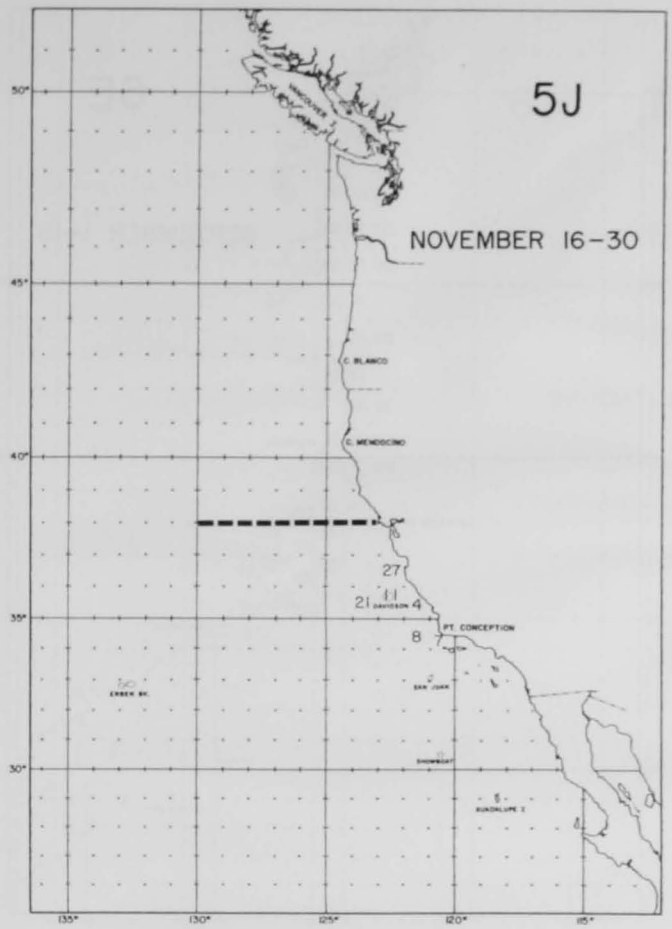

5E
SEPTEMBER 1-15
VANCOUVER
C. BLANCO
MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


5F
SEPTEMBER 16-30
86 52
142 48 51 165
91 127 42
26 91
29 11 4
4
C. BLANCO
4
74 129 2
C. MENDOCINO
87 113 44
63 82
11 3 33 64
116 71 67
74 107
DAVIDSON
103
103
PT. CONCEPTION
108 90
93 55
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


5G
OCTOBER 1-15
43 68
108 45
114
250
C. BLANCO
87 107
C. MENDOCINO
142 12
12 22
128 58 33
35 48 11
56
DAVIDSON
85 27
PT. CONCEPTION
38 112 93 85
188
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


5H
OCTOBER 16-31
187 49
143 66
28 61
3
C. BLANCO
99 98 94
MENDOCINO
19 3
15 31
36 17
50 35 26
57
DAVIDSON
45
PT. CONCEPTION
47 48
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


51
NOVEMBER 1-15
1
C. BLANCO
45 20 60
MENDOCINO
2
32 50
34
124
DAVIDSON
35
PT. CONCEPTION
40 26
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°



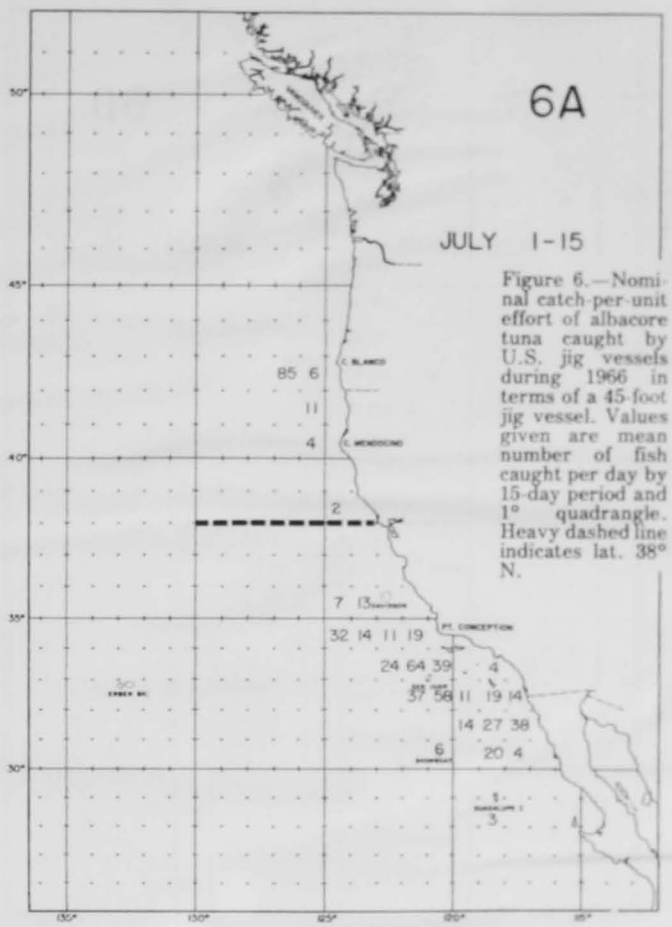
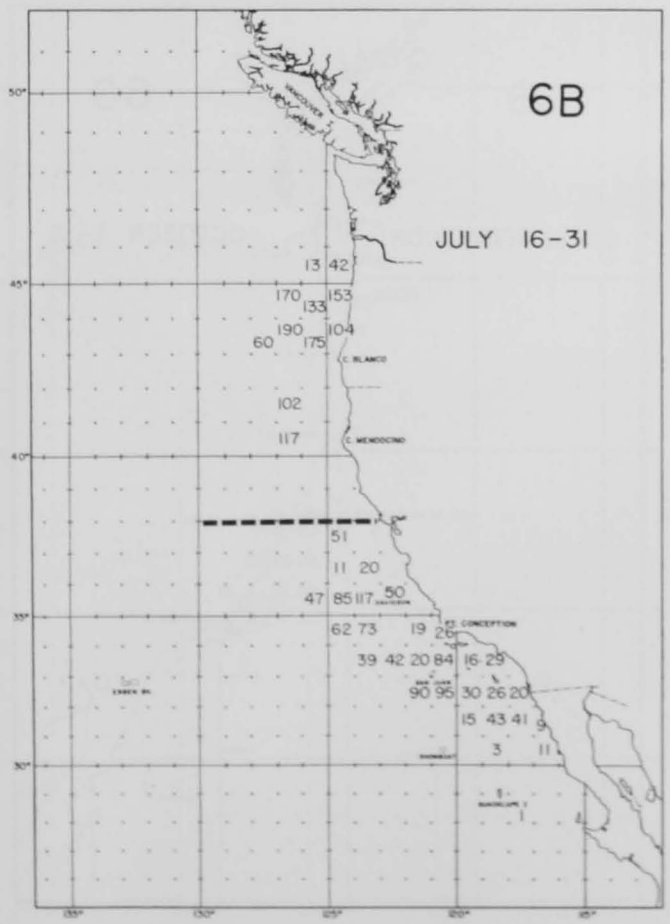
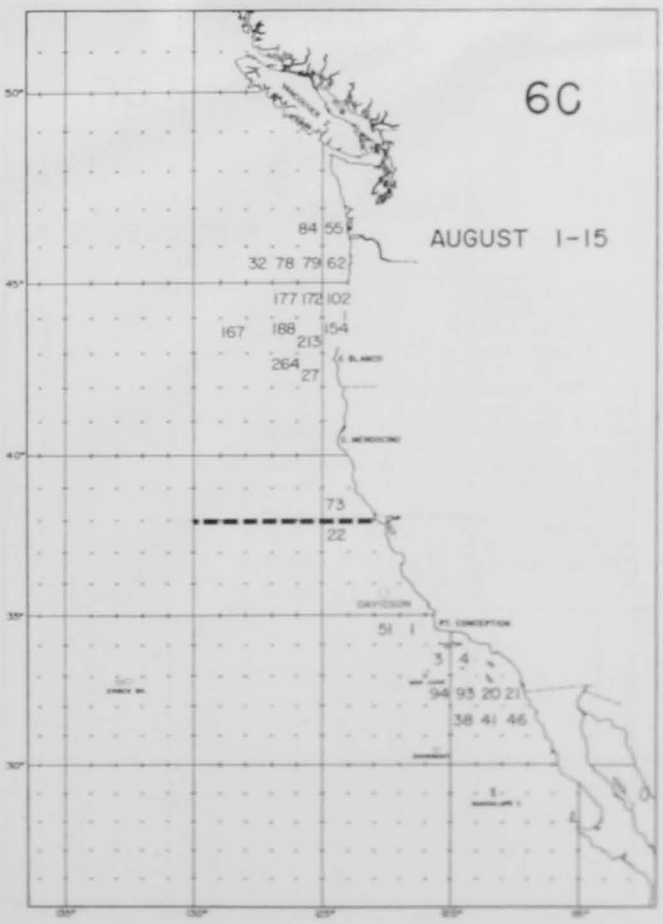
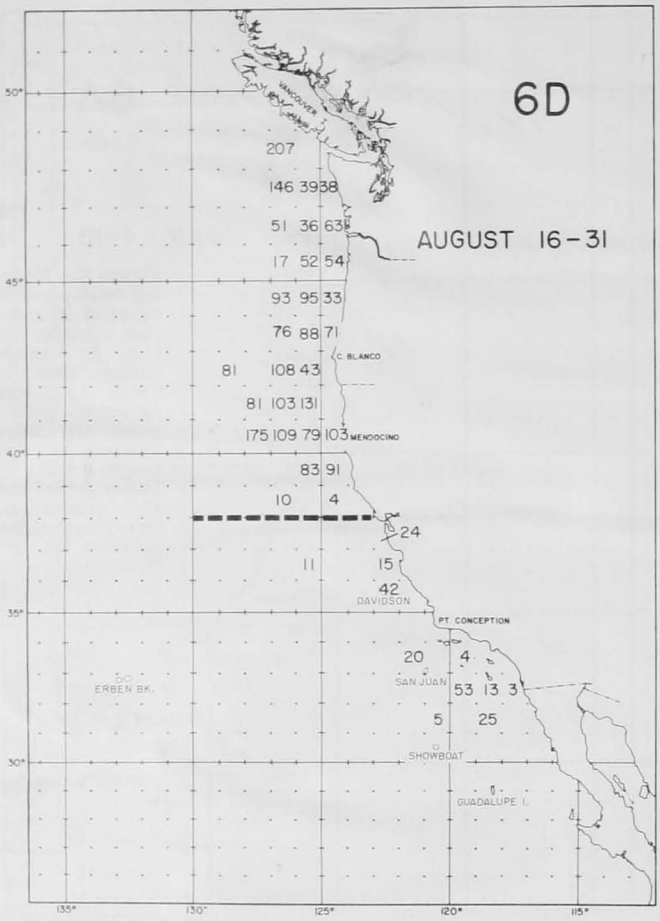
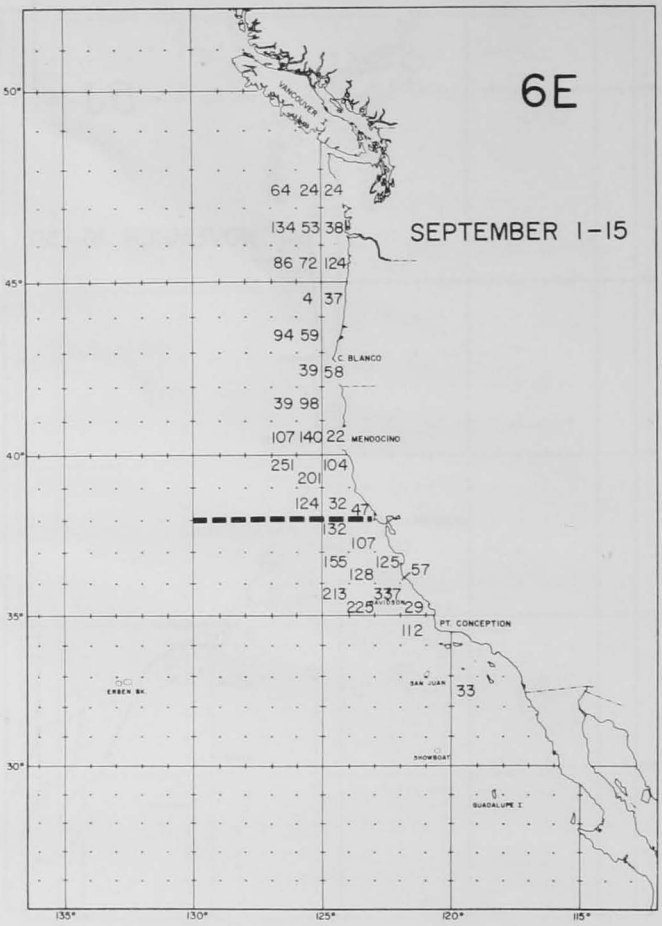


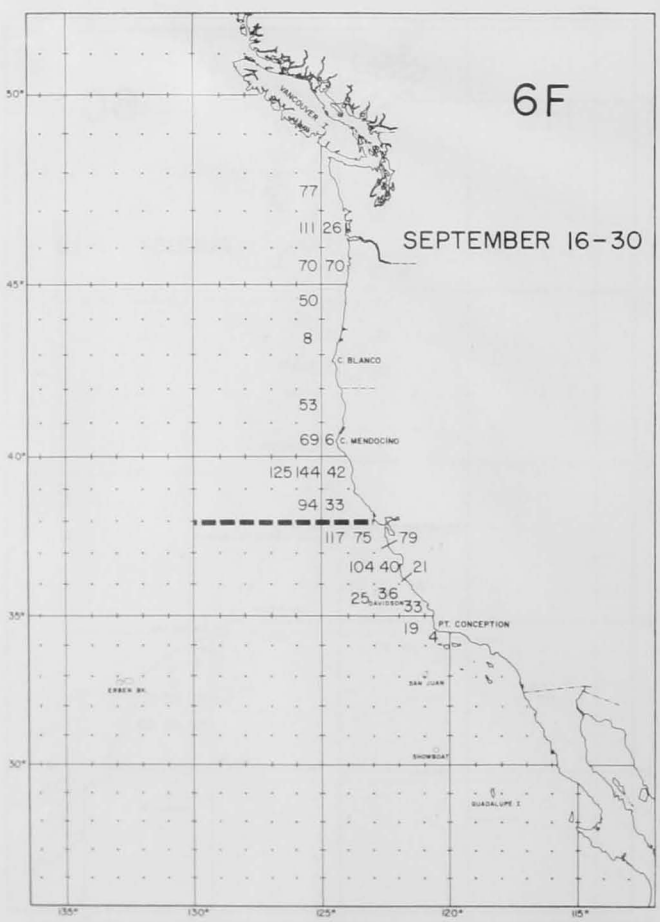
Figure 6.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1966 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

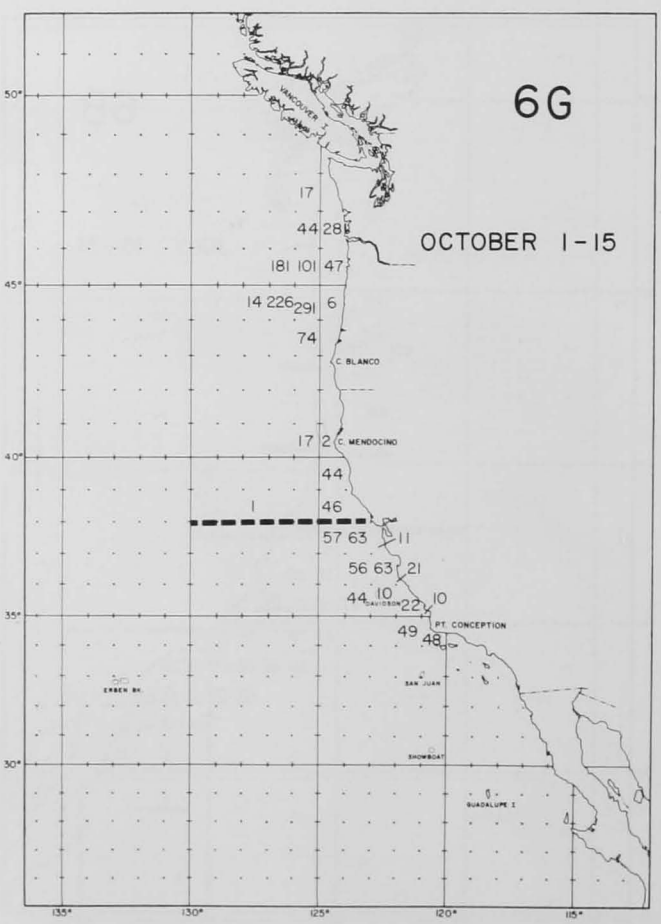


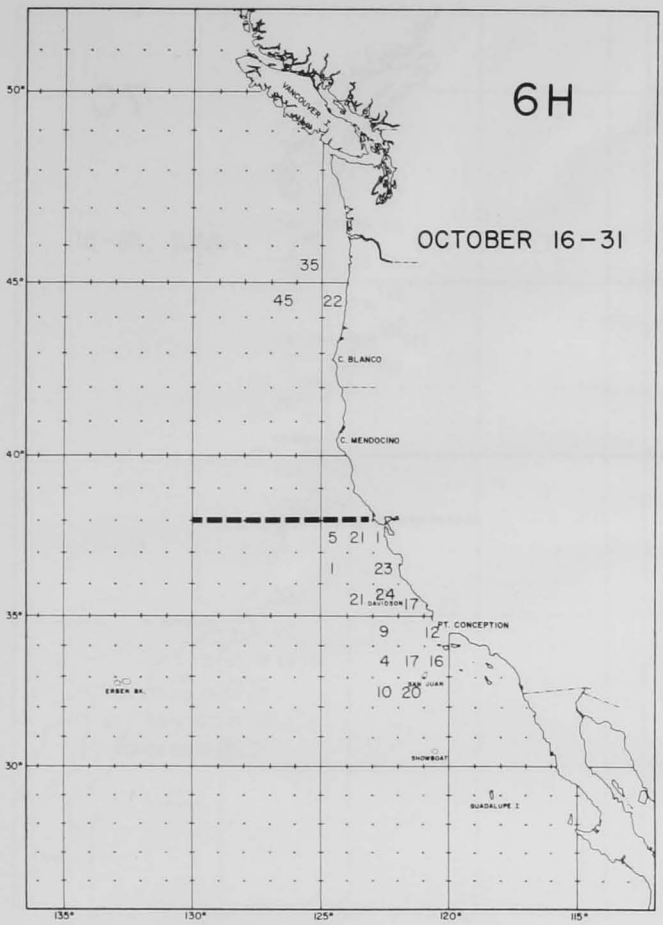


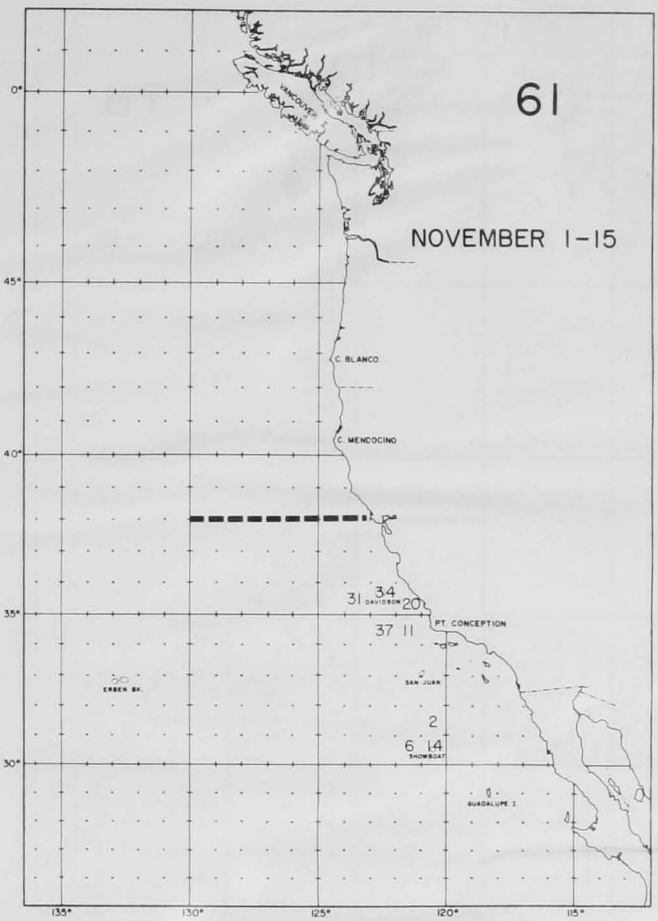

6D
AUGUST 16-31
VANCOUVER
207
146 39 38
51 36 63
17 52 54
93 95 33
76 88 71
C. BLANCO
81 108 43
81 103 131
175 109 79 103
MENDOCINO
83 91
10 4
24
11 15
42
DAVIDSON
PT. CONCEPTION
20 4
SAN JUAN
53 13 3
5 25
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

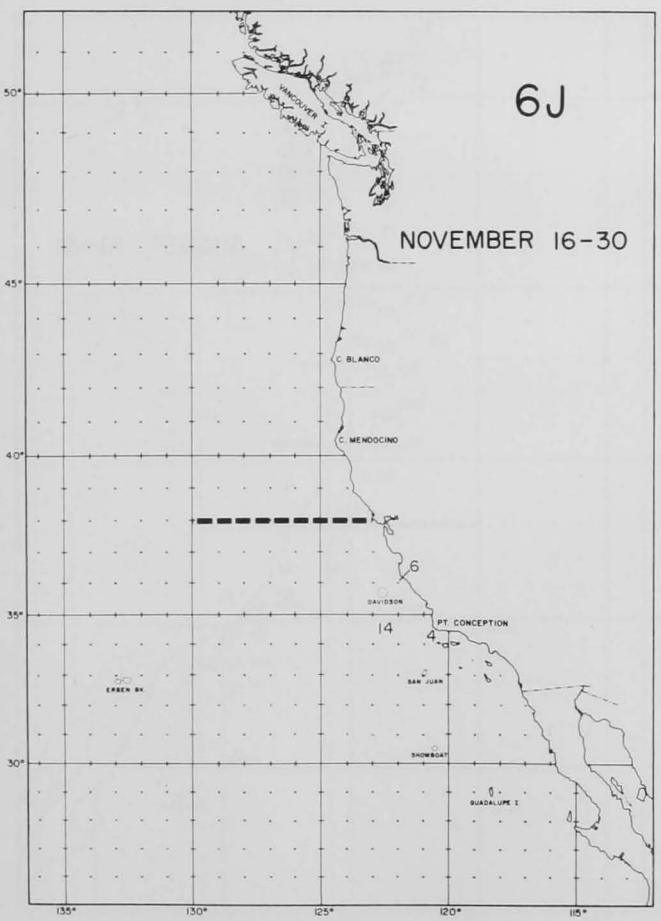

6E
SEPTEMBER 1-15
VANCOUVER
64 24 24
134 53 38
86 72 124
4 37
94 59
C. BLANCO
39 58
39 98
107 140 22
MENDOCINO
251 104
201
124 32 47
32
107
155 125 57
128
213 337
225
DAVIDSON
29
112
PT. CONCEPTION
SAN JUAN
33
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


6F
SEPTEMBER 16-30
VANCOUVER
77
111 26
70 70
50
8
C. BLANCO
53
69 6
C. MENDOCINO
125 144 42
94 33
117 75 79
104 40 21
25 36
DAVIDSON
33
19
PT. CONCEPTION
4
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


6G
OCTOBER 1-15
VANCOUVER
17
44 28
181 101 47
14 226 291 6
74
C. BLANCO
17 2
C. MENDOCINO
44
1
46
57 63 11
56 63 21
44 10 22 10
DAVIDSON
PT. CONCEPTION
49 48
SAN JUAN
SHOWBOAT
GUADALUPE I.
ERBEN BK.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°







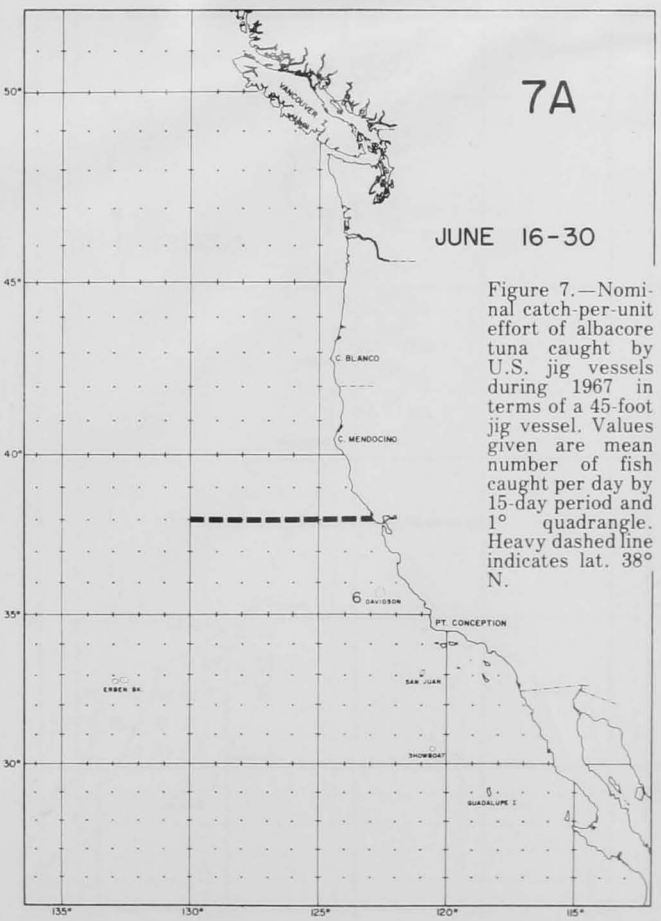
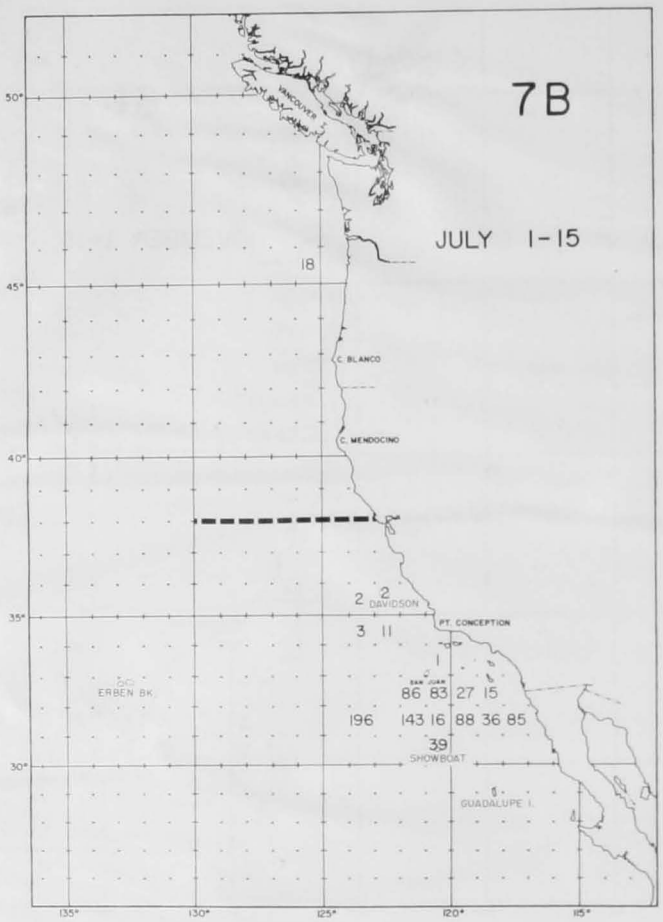
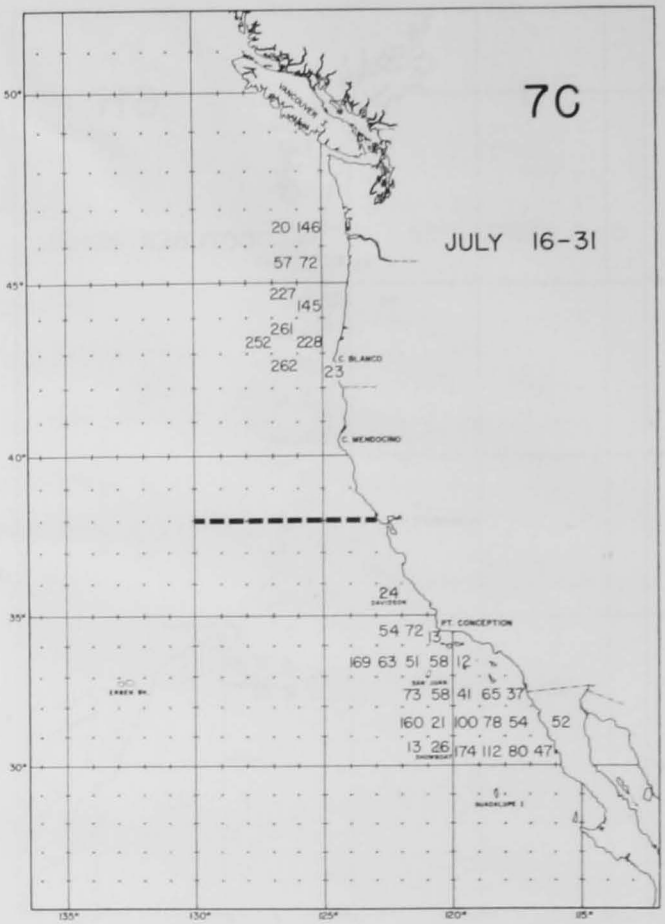
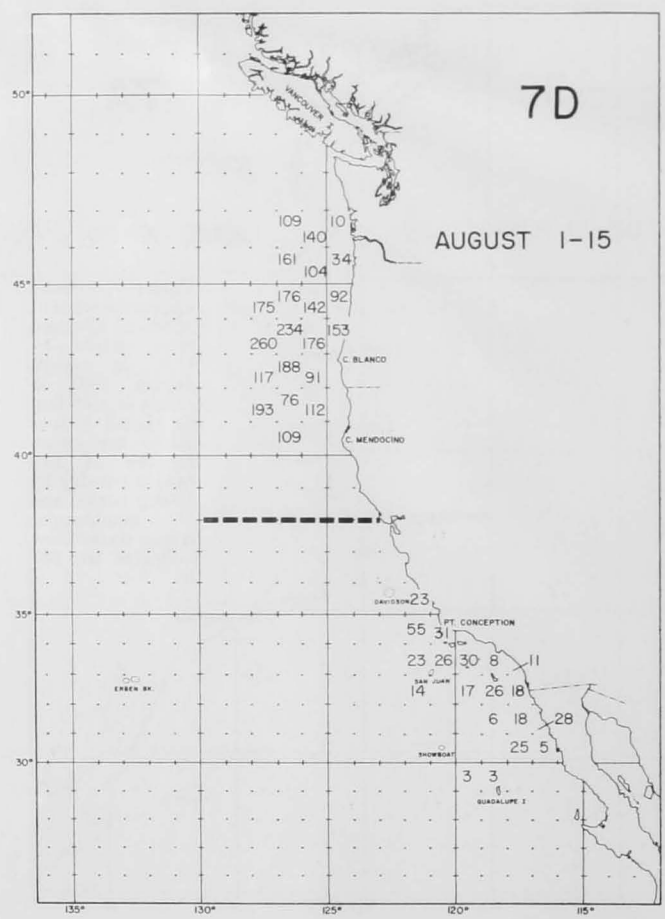
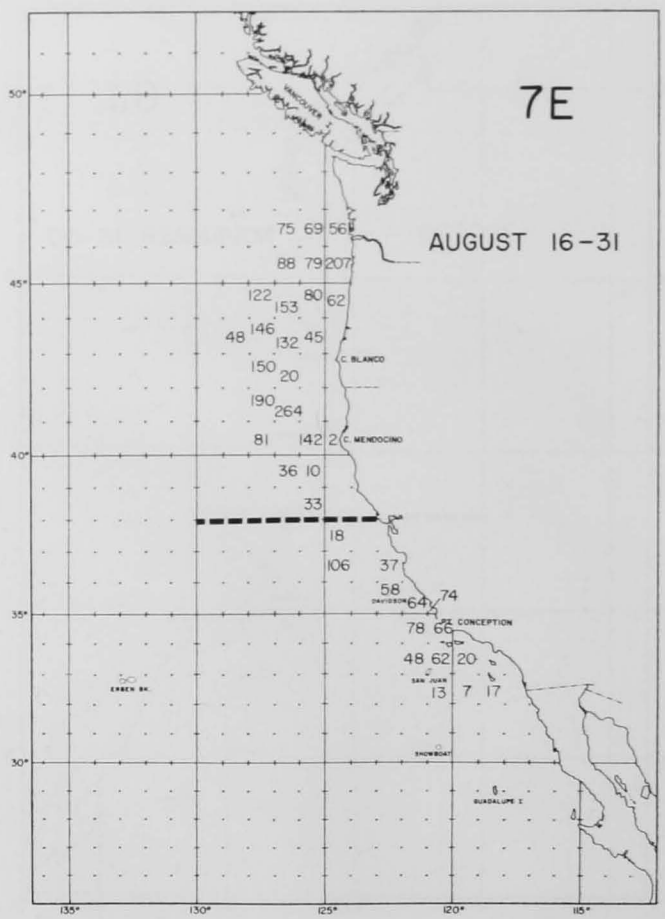


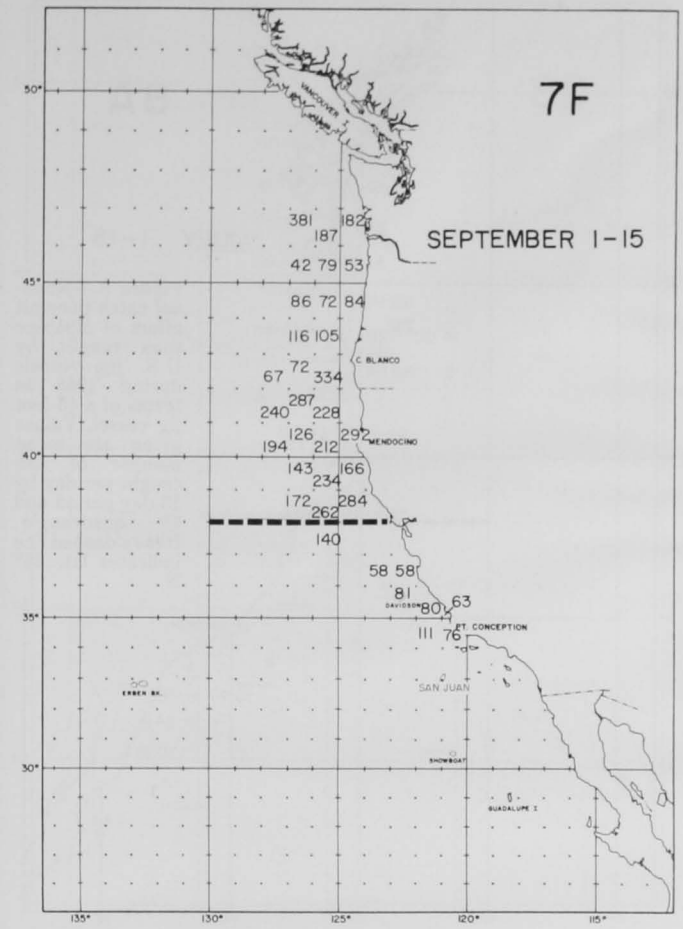
Figure 7.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1967 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

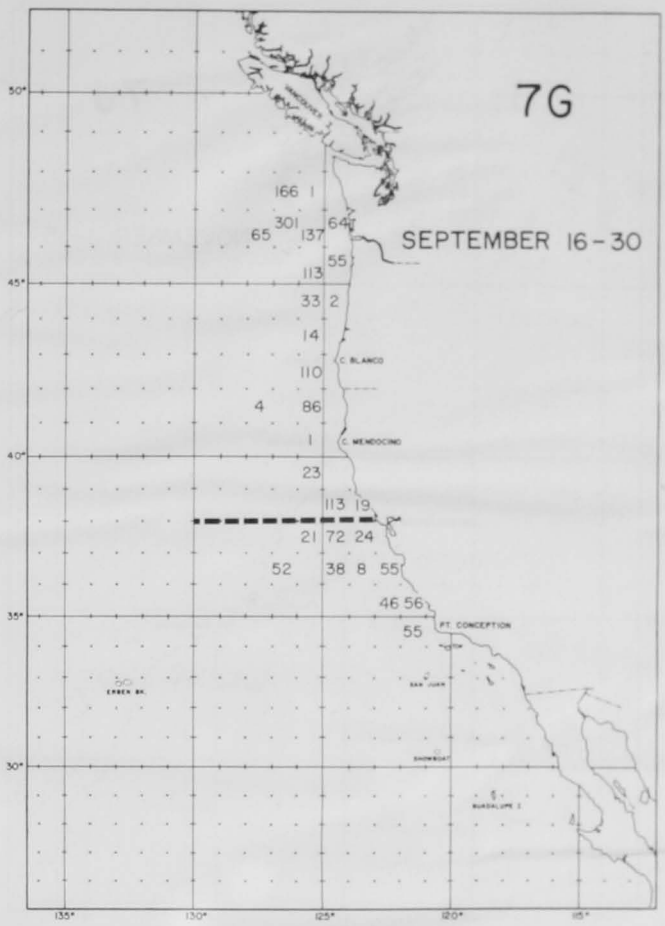

7B
JULY 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
18
2 2
3 11
1
86 83 27 15
196 143 16 88 36 85
39

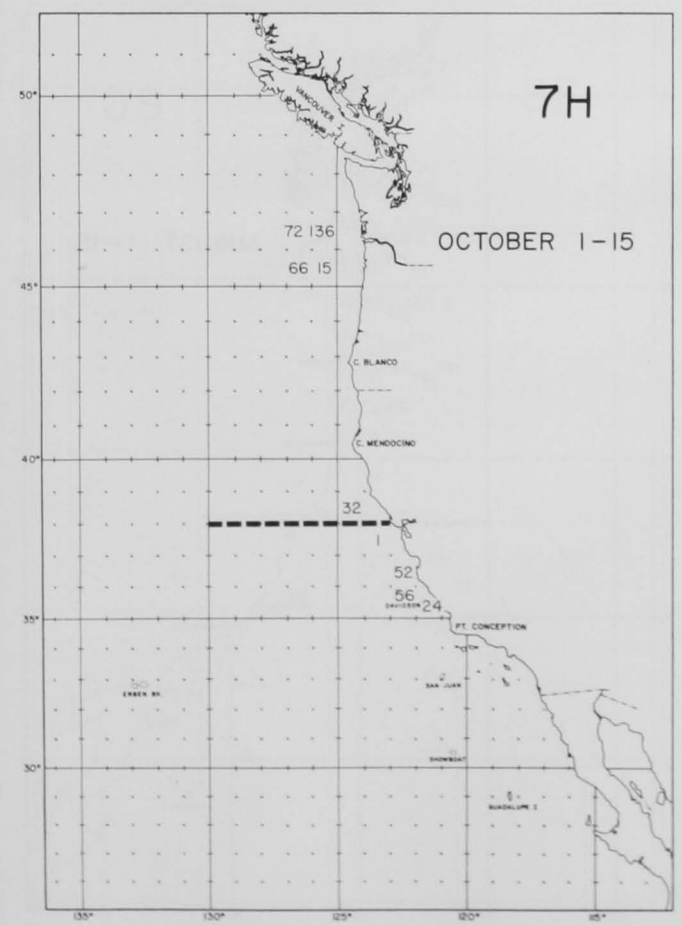

7C
JULY 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
20 146
57 72
227
145
261
252 228
262
23
24
54 72
3
169 63 51 58 12
73 58 41 65 37
160 21 100 78 54 52
13 26 174 112 80 47

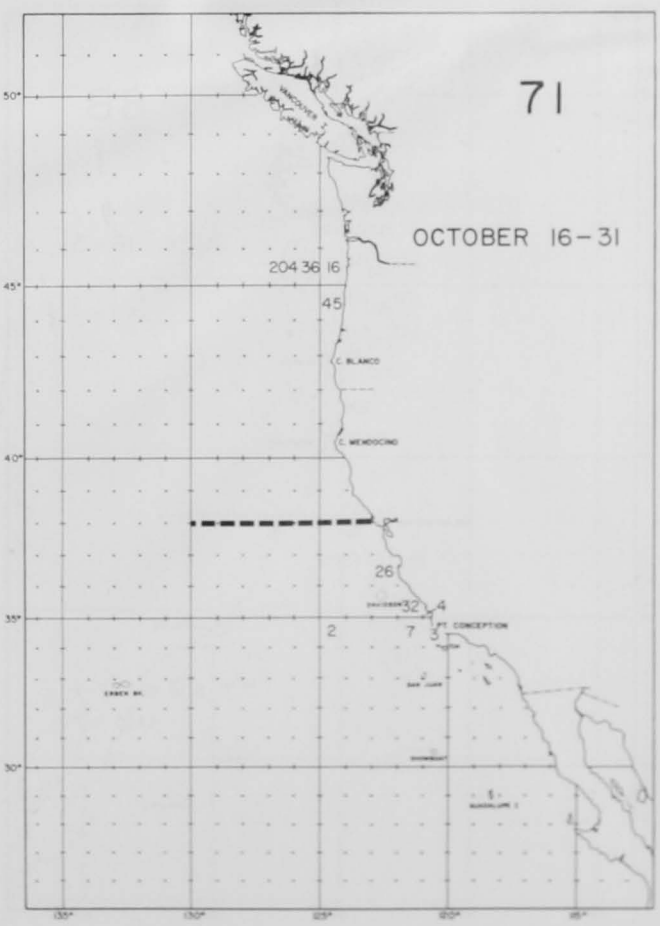

7D
AUGUST 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
109 10
140
161 34
104
175 176 142 92
234 153
260 176
188
117 91
193 76 112
109
23
55 31
23 26 30 8 11
14 17 26 18
6 18 28
25 5
3 3

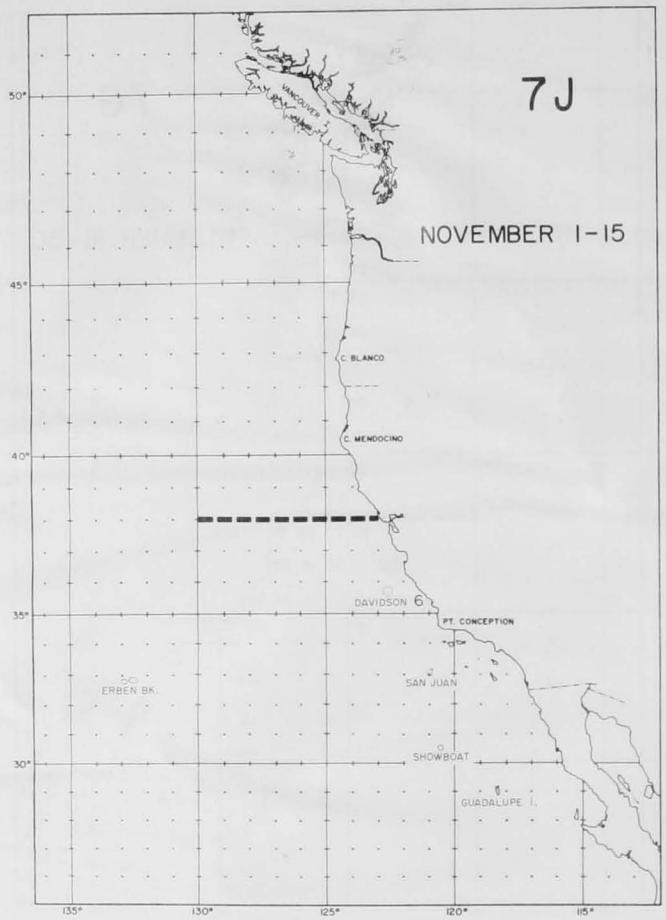

7E
AUGUST 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
ERBEN BK.
GUADALUPE I.
75 69 56
88 79 207
122 153 80 62
48 146 132 45
150 20
190 264
81 142 2
36 10
33
18
106 37
58
64 74
78 66
48 62 20
13 7 17


7F
SEPTEMBER 1-15
381 182
187
42 79 53
86 72 84
116 105
67 72 334
240 287 228
194 126 212 292
143 234 166
172 262 284
140
58 58
81
80 63
111 76
C. BLANCO
MENDOCINO
FT. CONCEPTION
SAN JUAN
ERBEN BK.
SNOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


7G
SEPTEMBER 16-30
166 1
65 301 137 64
55
113
33 2
14
110
4 86
1
23
113 19
21 72 24
52 38 8 55
46 56
55
C. BLANCO
C. MENDOCINO
FT. CONCEPTION
ERBEN BK.
SNOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°


7H
OCTOBER 1-15
72 136
66 15
C. BLANCO
C. MENDOCINO
32
1
52
56 24
FT. CONCEPTION
ERBEN BK.
SNOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°


7I
OCTOBER 16-31
204 36 16
45
C. BLANCO
C. MENDOCINO
26
32 4
2 7 3
FT. CONCEPTION
ERBEN BK.
SNOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°



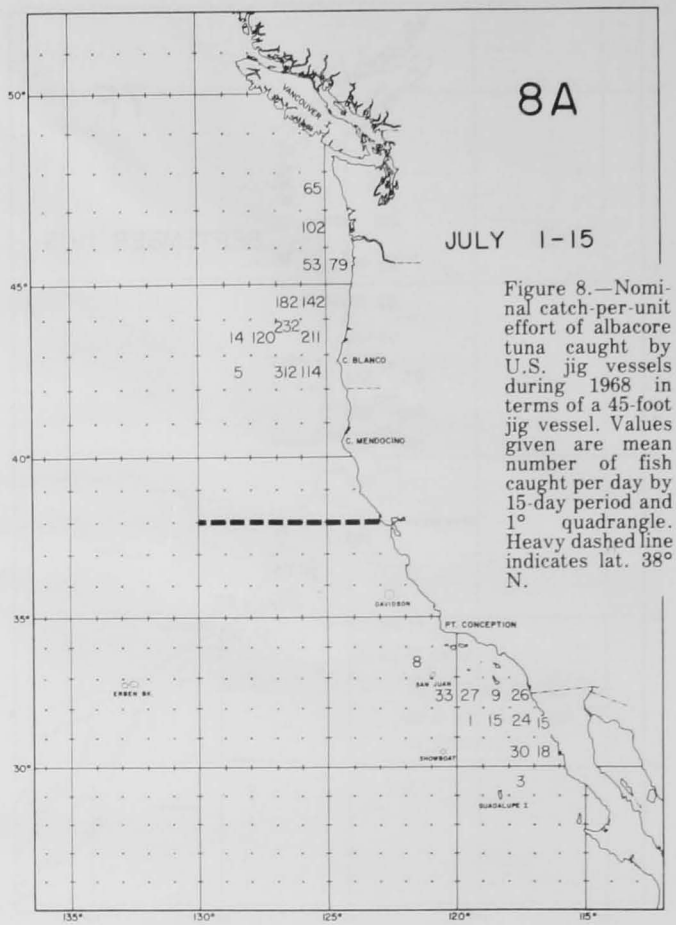
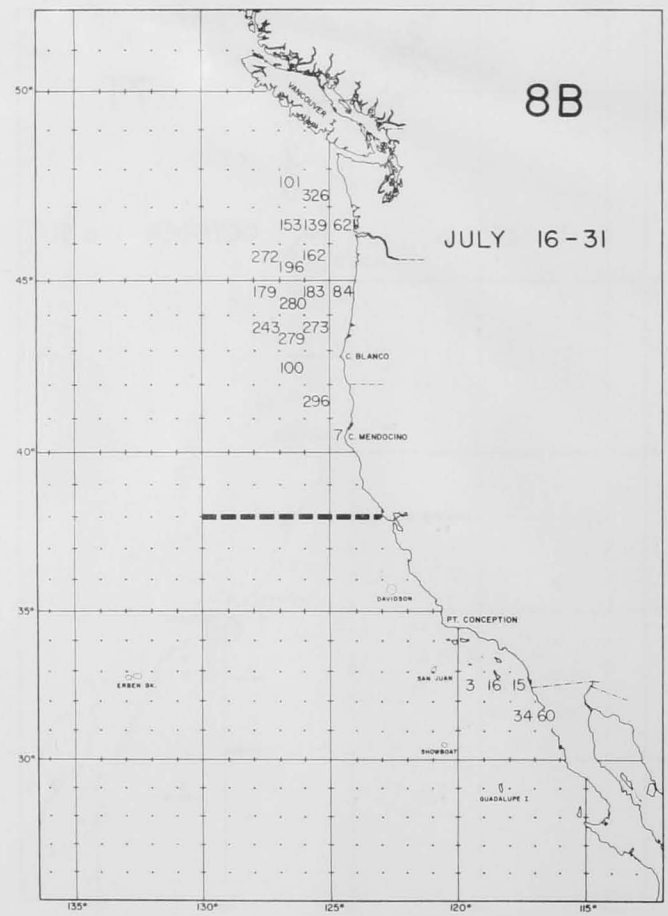
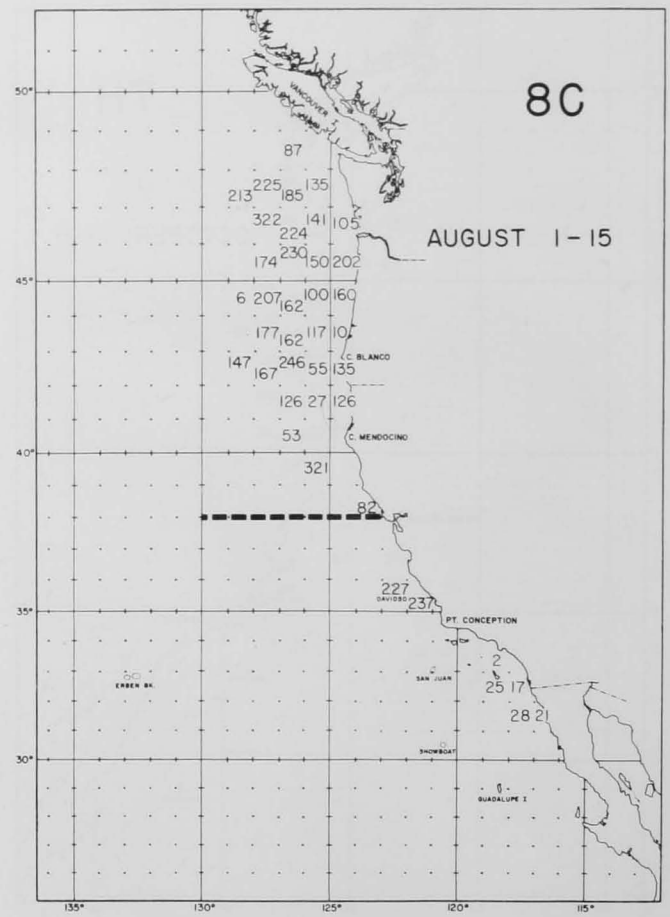
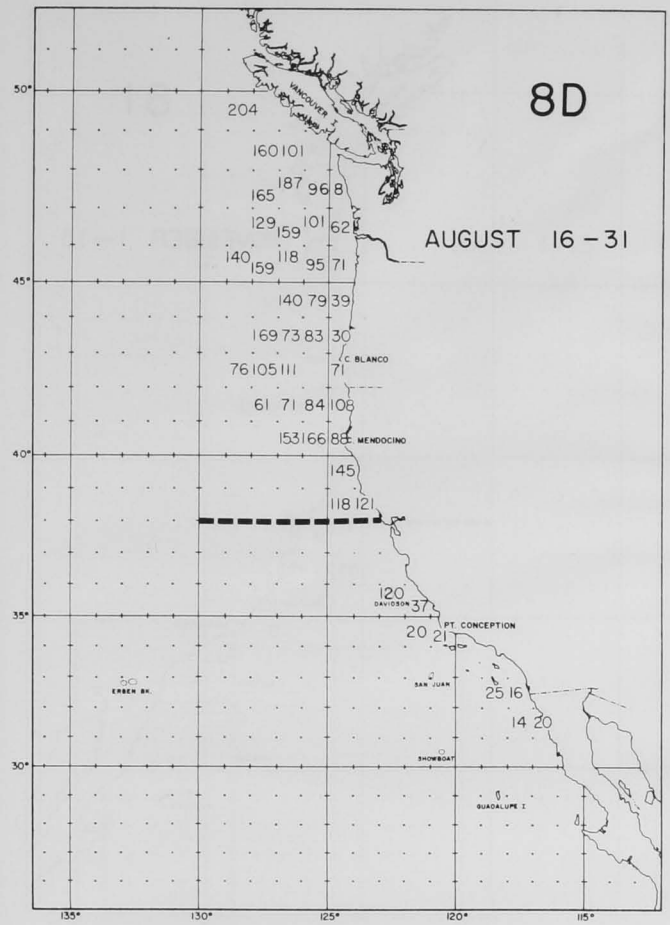
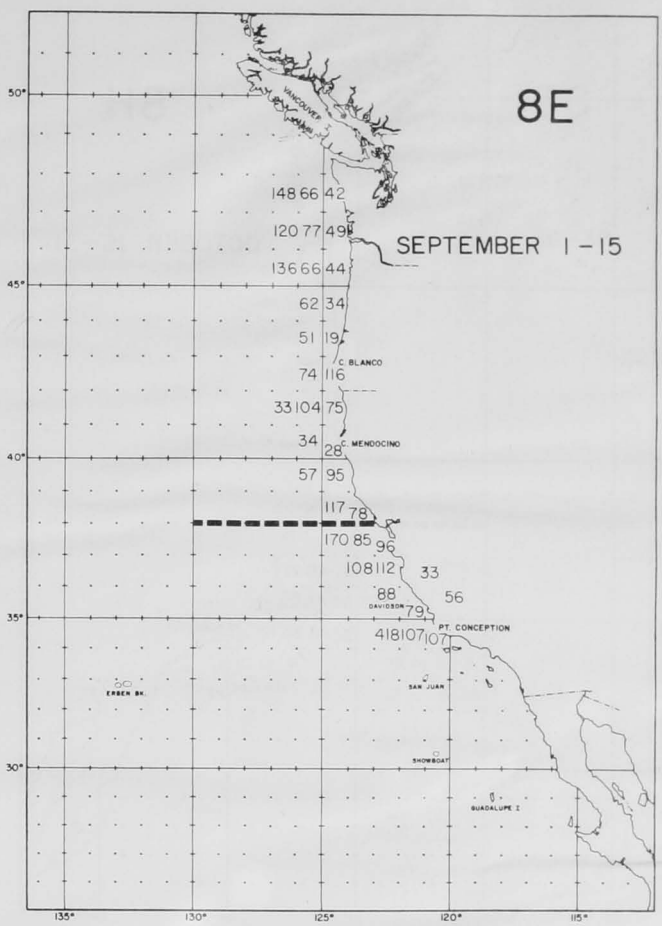


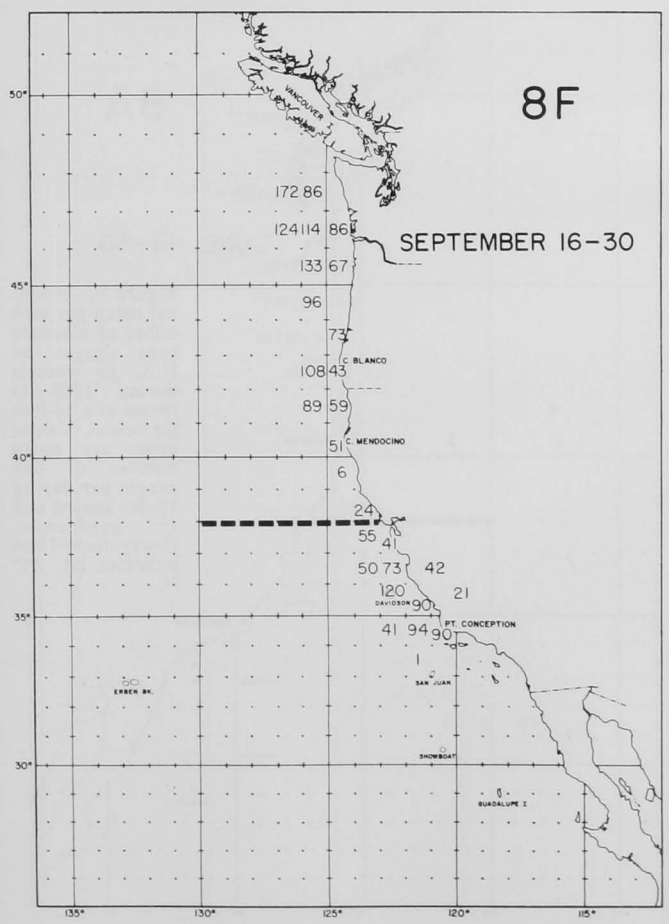
Figure 8.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1968 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

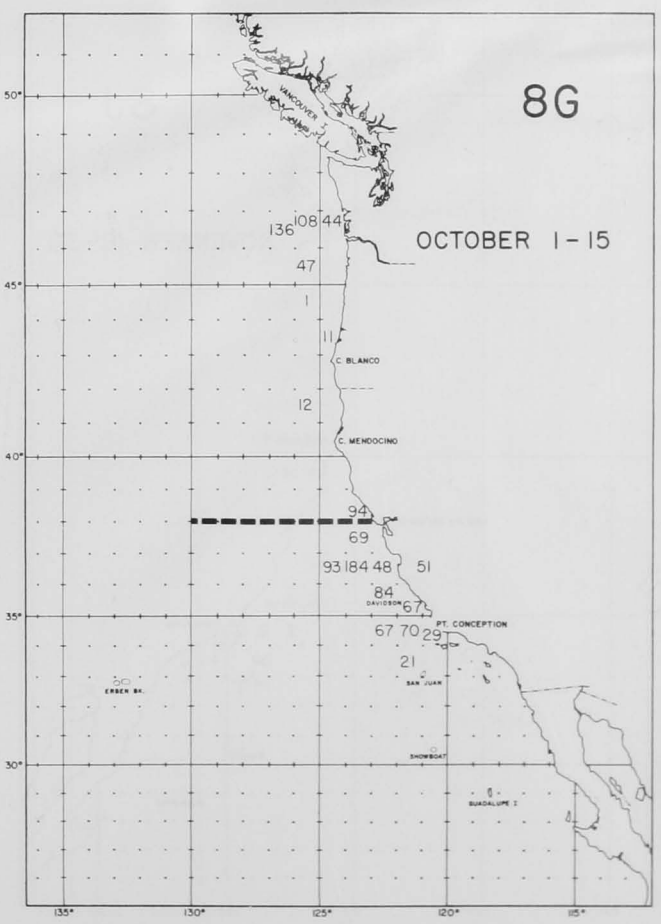


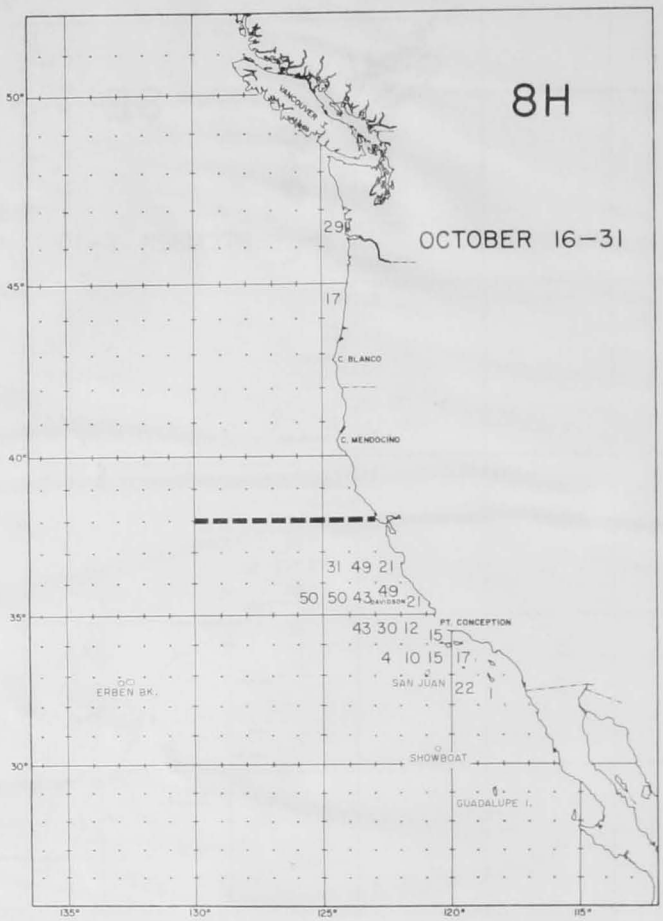


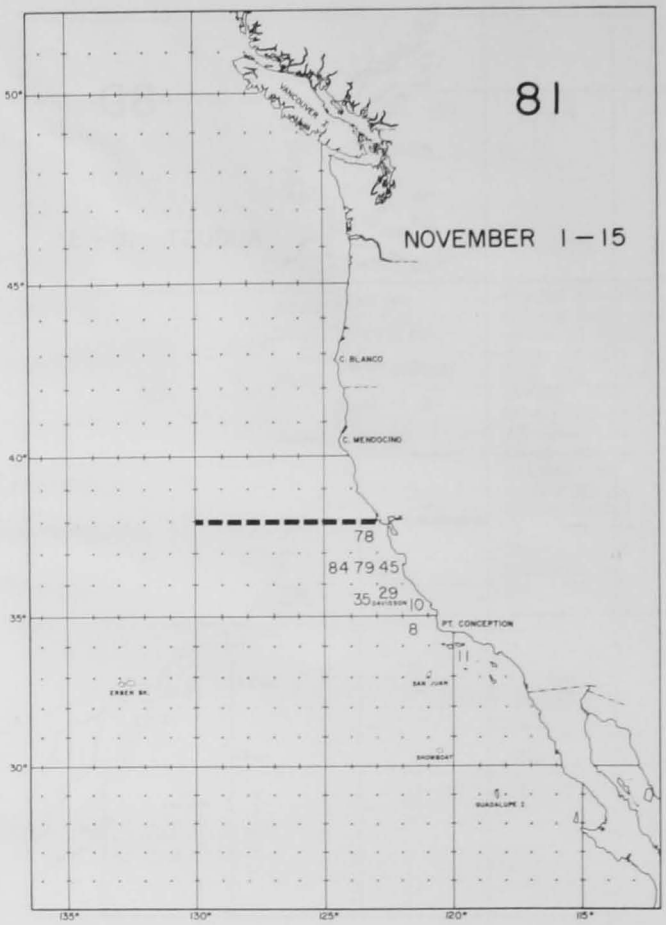

8D
AUGUST 16 - 31
VANCOUVER
C. BLANCO
MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
GUADALUPE I
ERBEN BK.
204
160 101
165 187 96 8
129 159 101 62
140 159 118 95 71
140 79 39
169 73 83 30
76 105 111 71
61 71 84 108
153 166 88
145
118 121
120
37
20 21
25 16
14 20
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

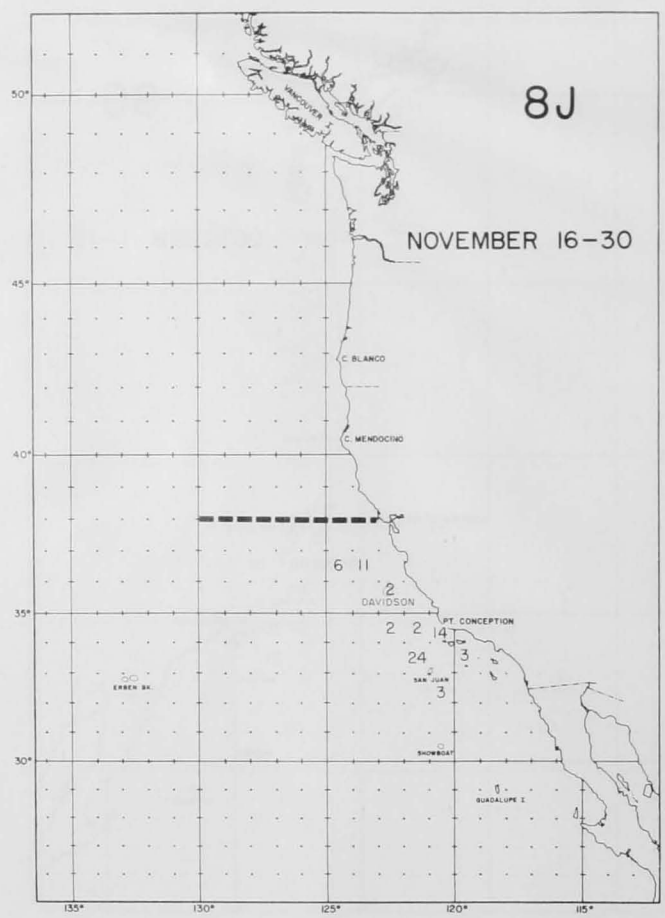

8E
SEPTEMBER 1 - 15
VANCOUVER
C. BLANCO
MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
GUADALUPE I
ERBEN BK.
148 66 42
120 77 49
136 66 44
62 34
51 19
74 116
33 104 75
34
28
57 95
117 78
170 85 96
108 112
33
88
56
79
41 81 107 107
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


8F
SEPTEMBER 16-30
VANCOUVER
C. BLANCO
MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
GUADALUPE I
ERBEN BK.
172 86
124 114 86
133 67
96
73
108 43
89 59
51
6
24
55
41
50 73 42
120
90
21
41 94 90
1
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


8G
OCTOBER 1 - 15
VANCOUVER
C. BLANCO
MENDOCINO
DAVIDSON
PT. CONCEPTION
SAN JUAN
SHOWBOAT
GUADALUPE I
ERBEN BK.
136 108 44
47
1
11
12
94
69
93 84 48
51
84
67
67 70 29
21
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°







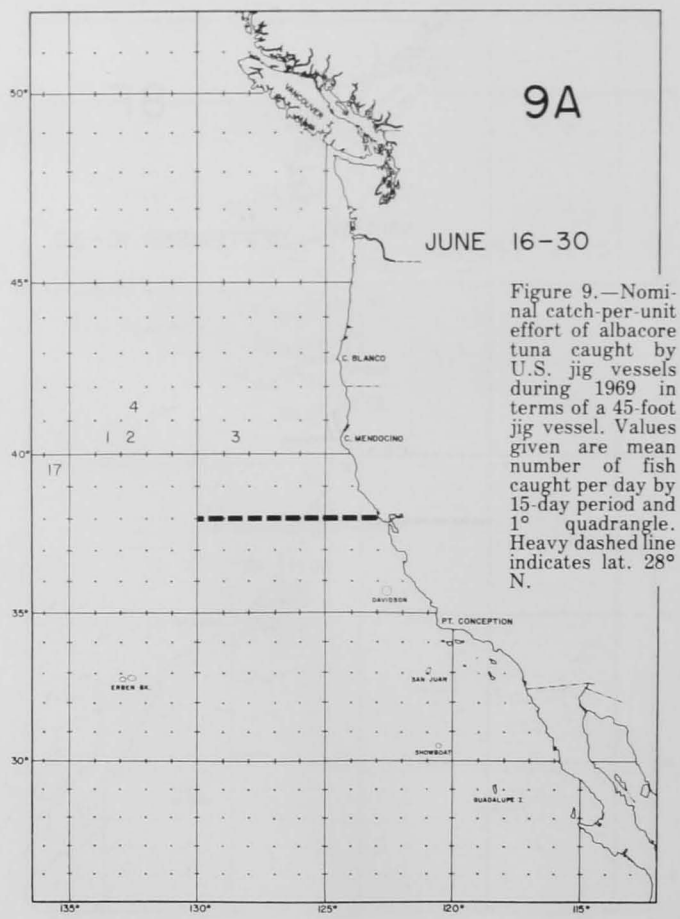
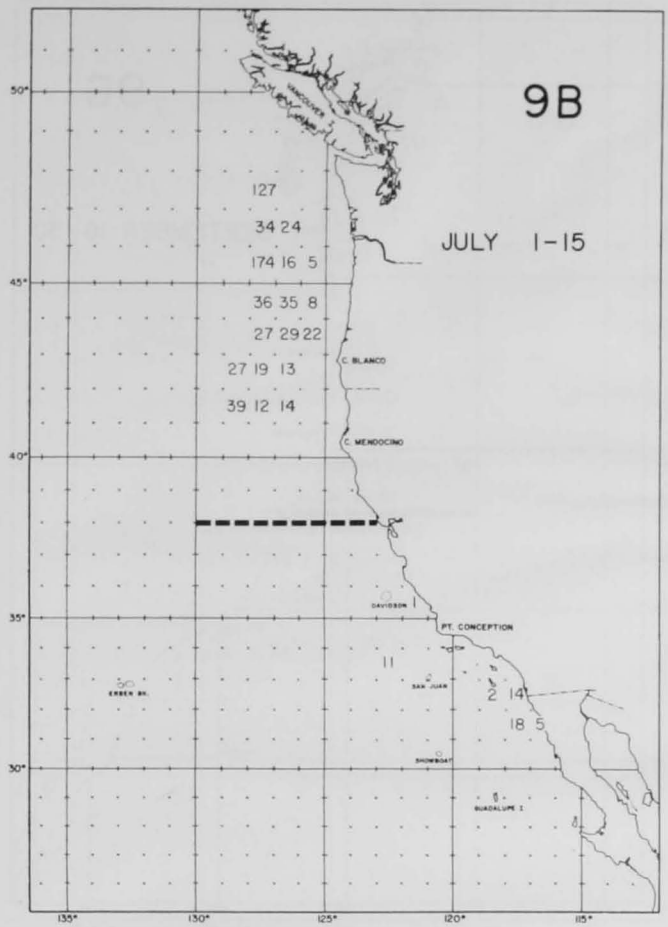
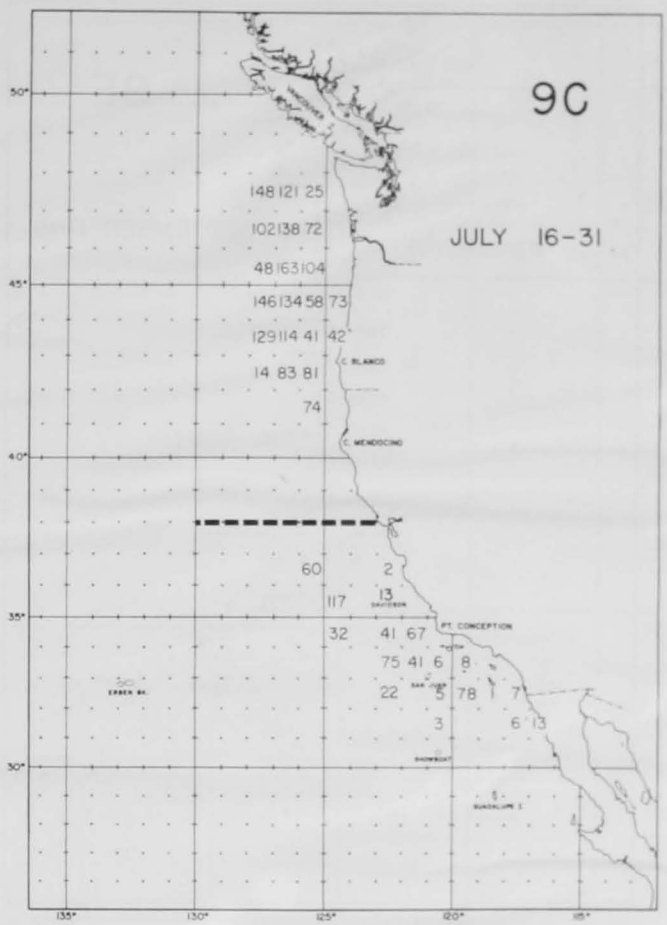
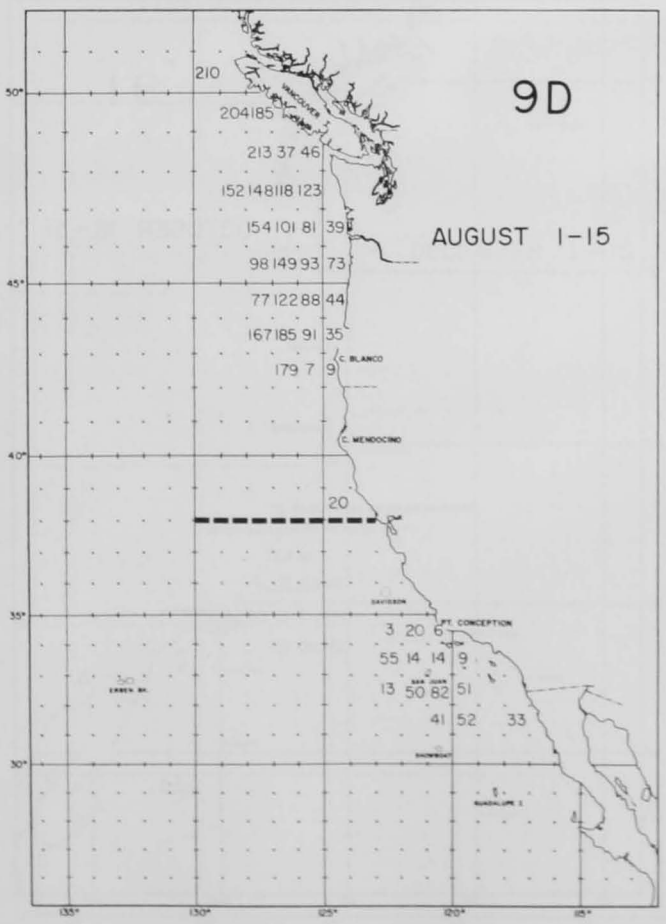
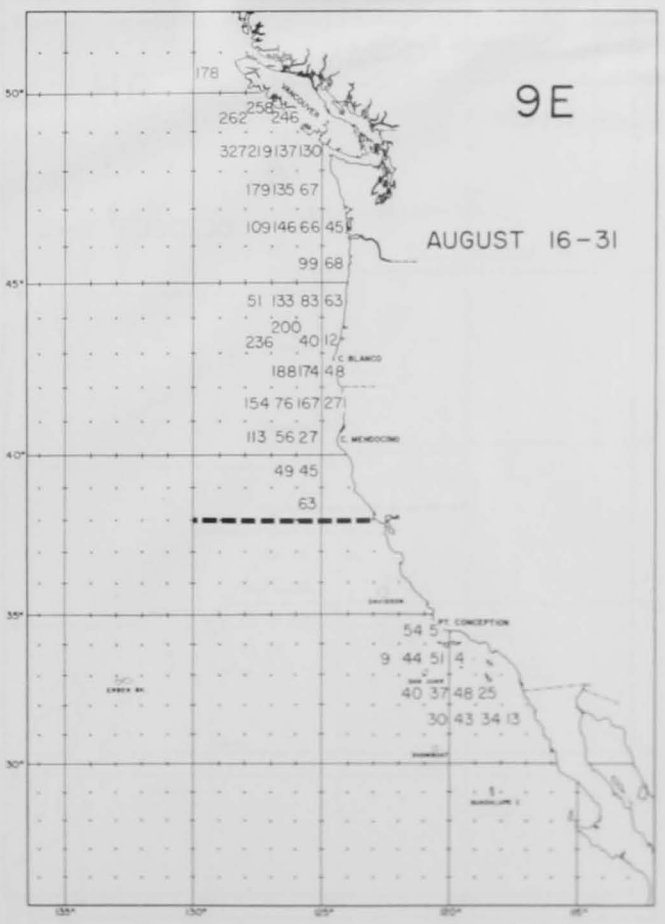


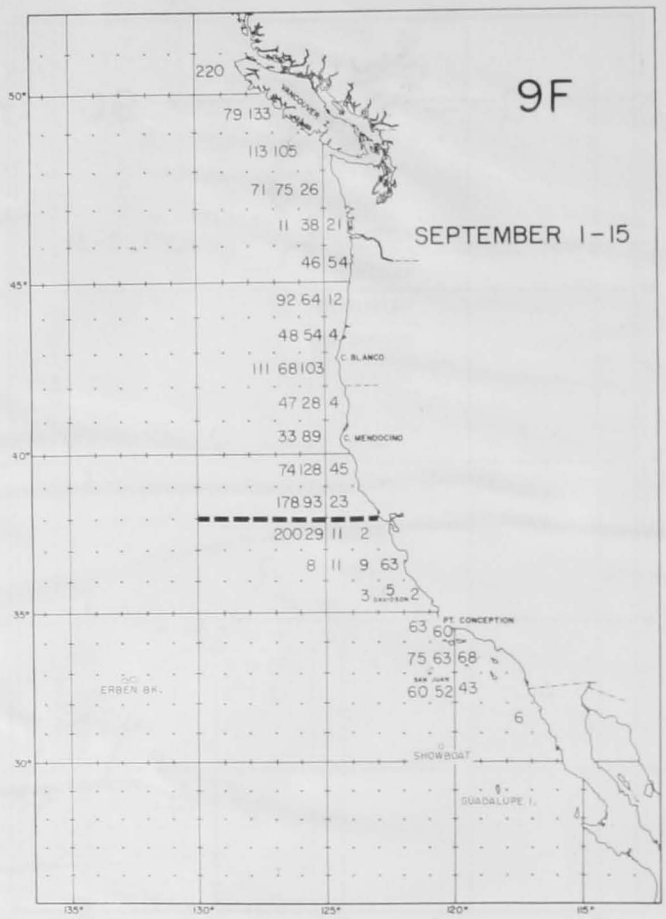
Figure 9.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1969 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 28° N.

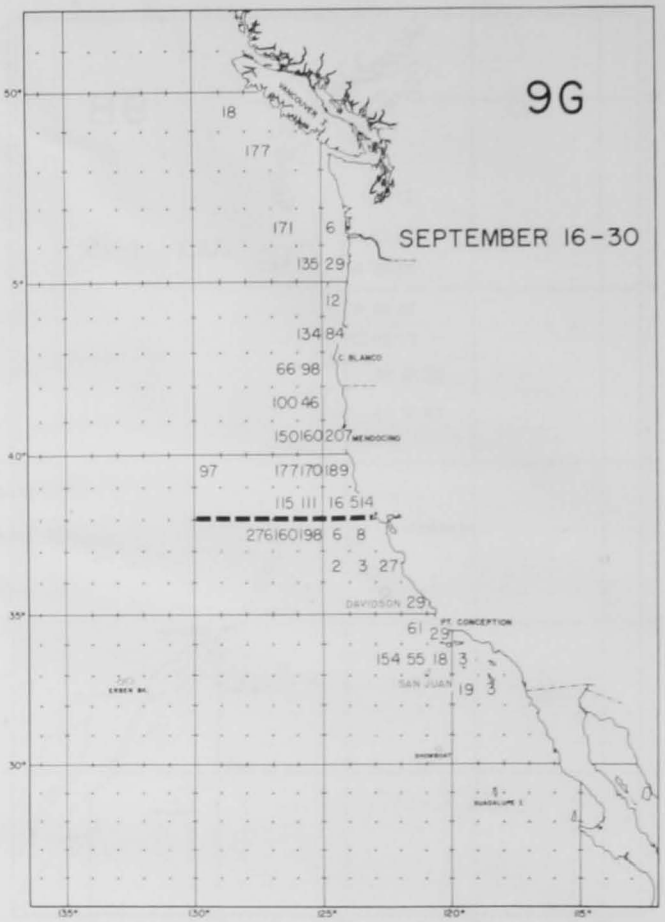

9B
JULY 1-15
127
34 24
174 16 5
36 35 8
27 29 22
27 19 13
39 12 14
11
2 14
18 5
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON 1
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

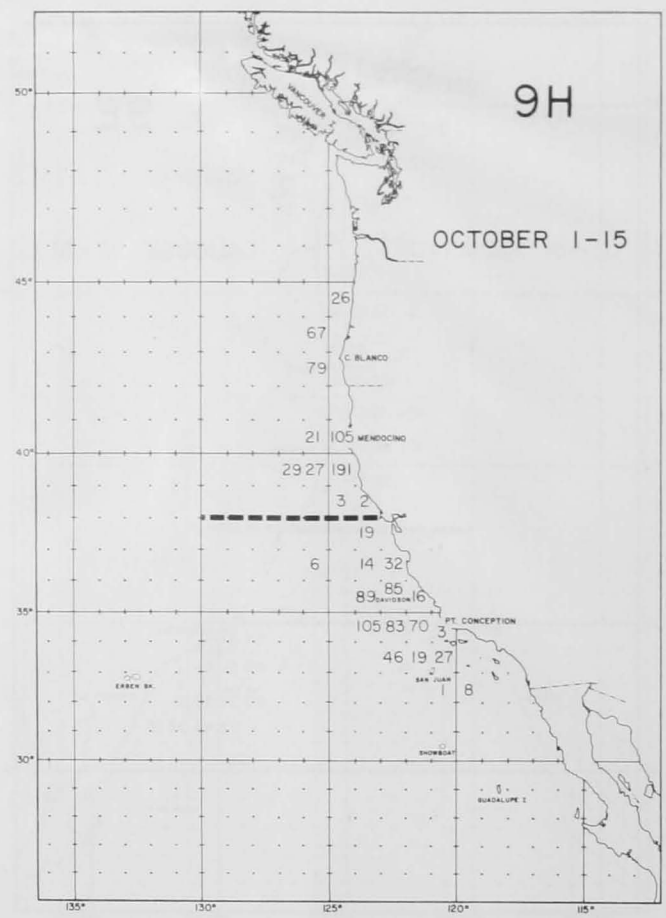

9C
JULY 16-31
148 121 25
102 138 72
48 163 104
146 134 58 73
129 114 41 42
14 83 81
74
60
2
117
13
32
41 67
75 41 6 8
22
5 78 1 7
3
6 13
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

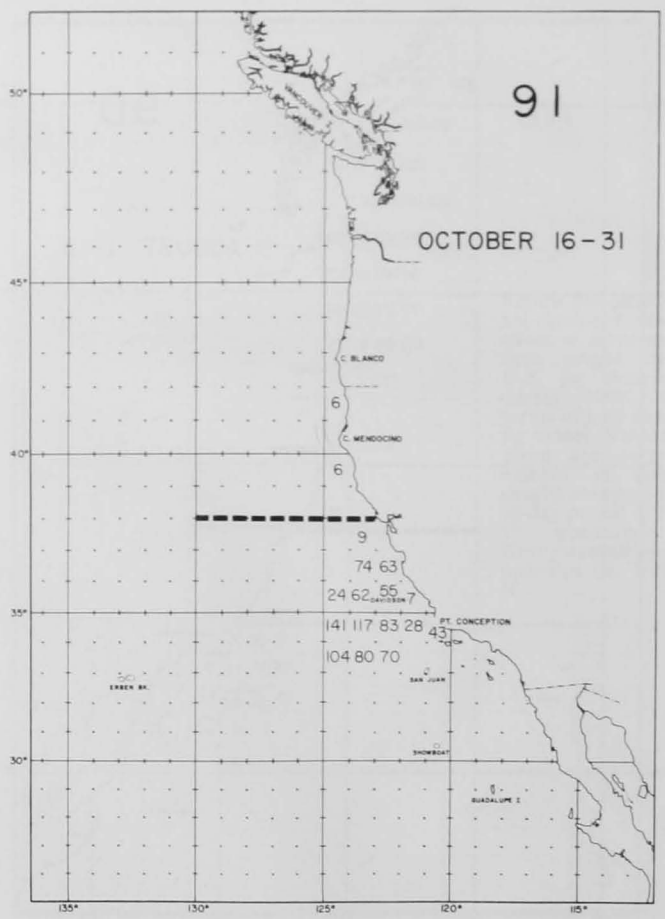

9D
AUGUST 1-15
210
204 185
213 37 46
152 148 118 123
154 101 81 39
98 149 93 73
77 122 88 44
167 185 91 35
179 7 9
20
3 20 6
55 14 14 9
13 50 82 51
41 52 33
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

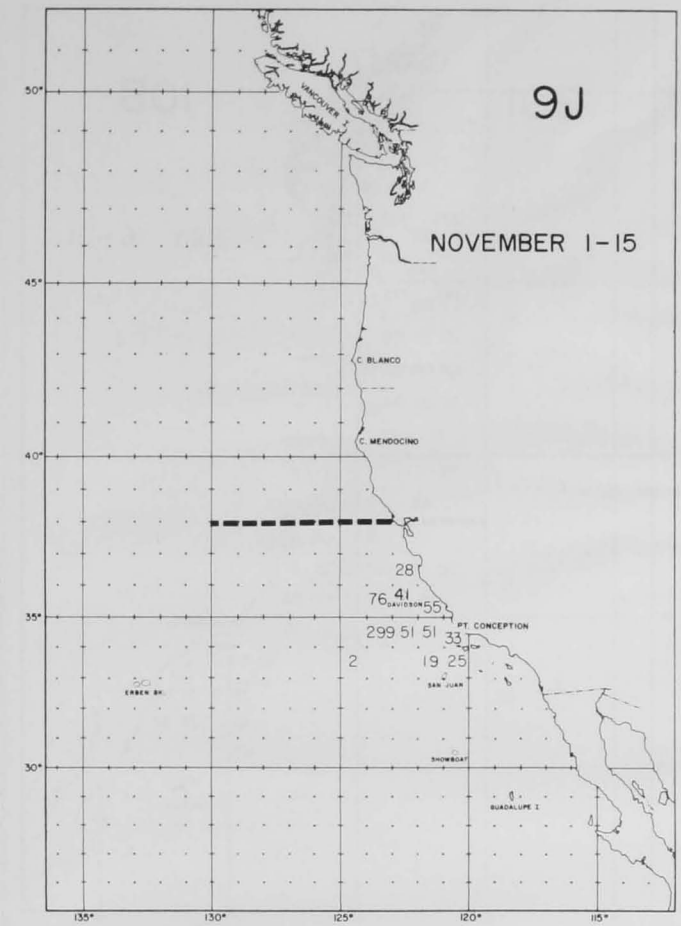

9E
AUGUST 16-31
178
262 258 246
327 219 137 130
179 135 67
109 146 66 45
99 68
51 133 83 63
200
236 40 12
188 174 48
154 76 167 27
113 56 27
49 45
63
54 5
9 44 51 4
40 37 48 25
30 43 34 13
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
DAVIDSON
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

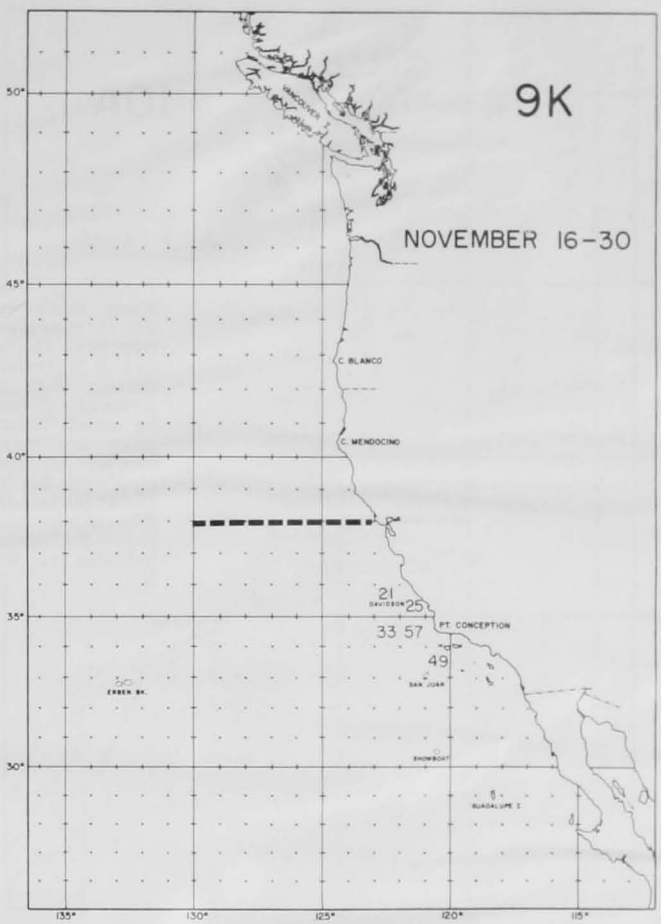

9F
SEPTEMBER 1-15
220
79 133
113 105
71 75 26
11 38 21
46 54
92 64 12
48 54 4
C. BLANCO
111 68 103
47 28 4
33 89
C. MENDOCINO
74 128 45
178 93 23
200 29 11 2
8 11 9 63
3 5 2
DAVIDSON
PT. CONCEPTION
63 60
75 63 68
SAN JUAN
60 52 43
6
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

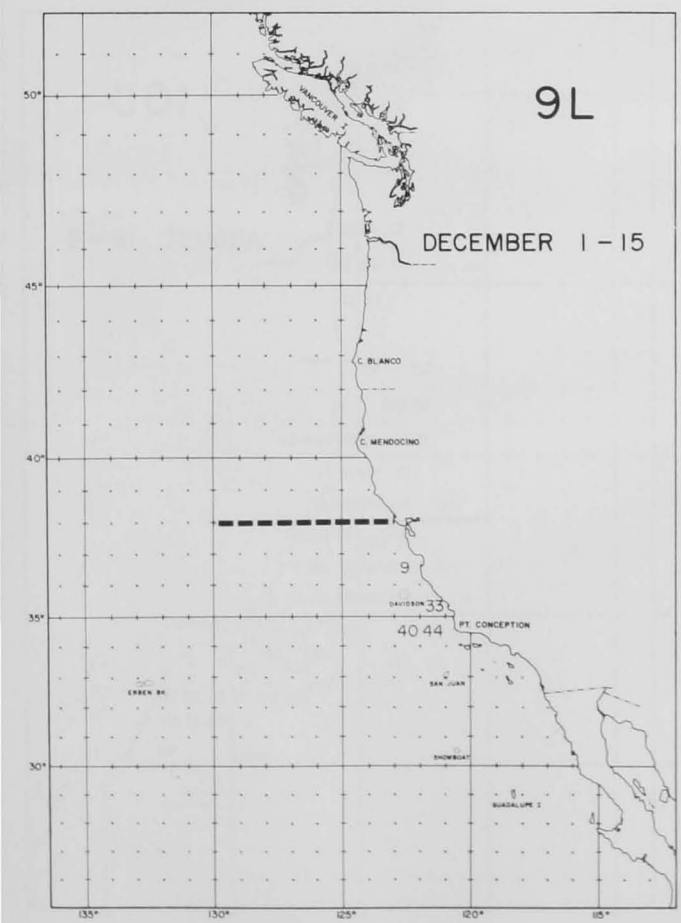

9G
SEPTEMBER 16-30
18
177
171 6
135 29
12
134 84
C. BLANCO
66 98
100 46
150 160 207
C. MENDOCINO
97 177 170 189
115 111 16 514
276 160 198 6 8
2 3 27
DAVIDSON 29
PT. CONCEPTION
61 29
154 55 18 3
SAN JUAN
19 3
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

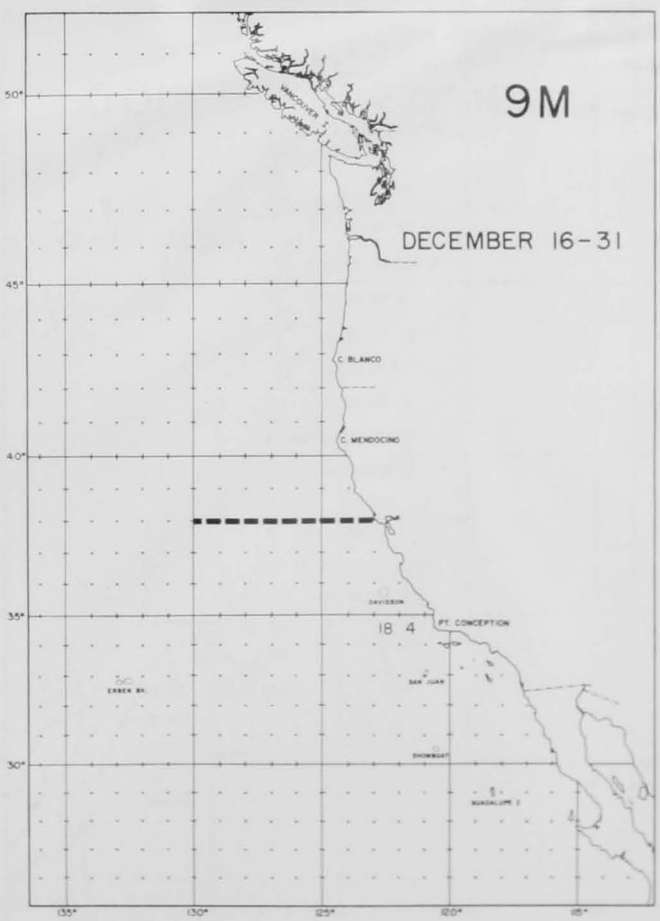

9H
OCTOBER 1-15
26
67
C. BLANCO
79
21 105
C. MENDOCINO
29 27 191
3 2
19
6
14 32
89 85
DAVIDSON 16
PT. CONCEPTION
105 83 70 3
46 19 27
SAN JUAN
1 8
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


9I
OCTOBER 16-31
C. BLANCO
6
C. MENDOCINO
6
9
74 63
24 62 55
DAVIDSON 7
PT. CONCEPTION
141 117 83 28 43
104 80 70
SAN JUAN
ERBEN BK.
SHOWBOAT
GUADALUPE I.
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


9J
NOVEMBER 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


9K
NOVEMBER 16-30
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


9L
DECEMBER 1-15
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


9M
DECEMBER 16-31
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SHOWBOAT
GUADALUPE I
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

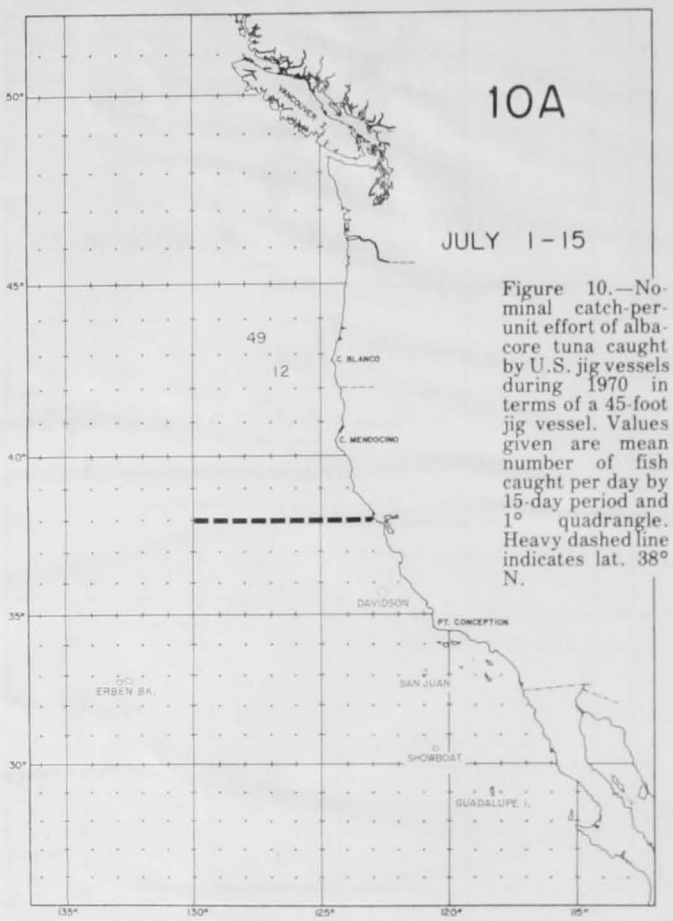
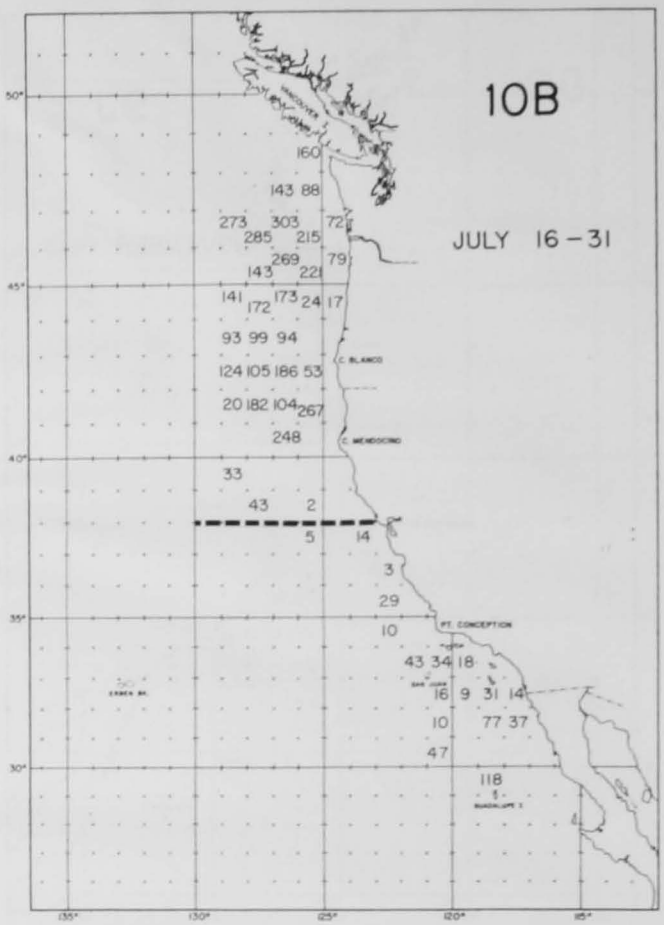
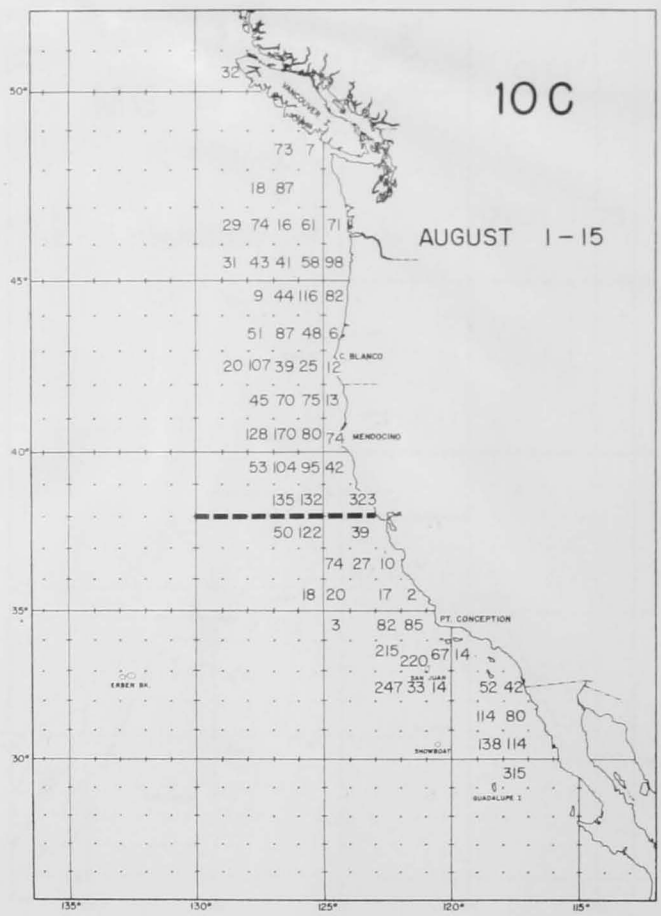
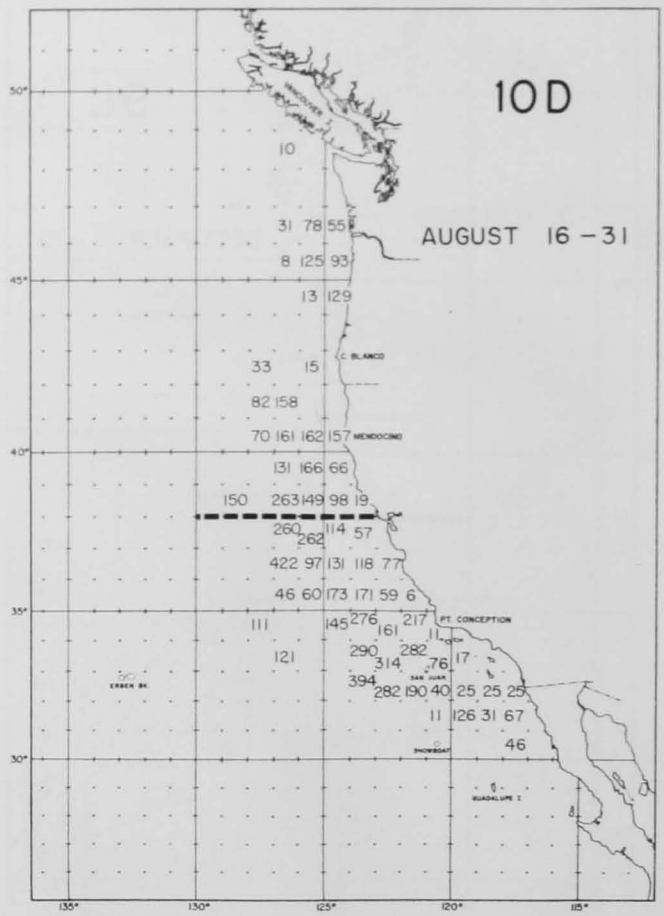
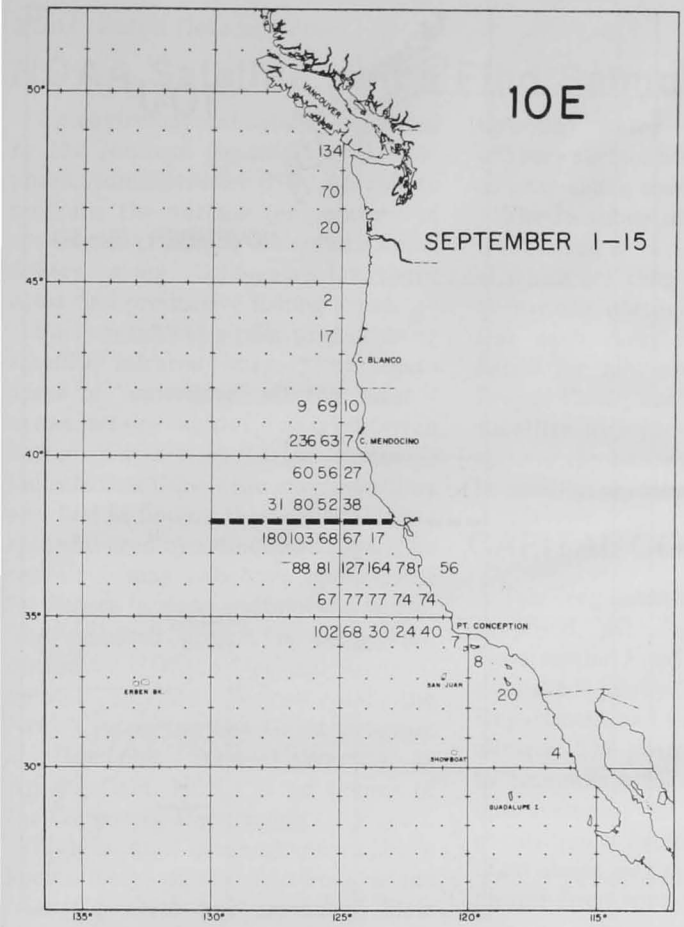


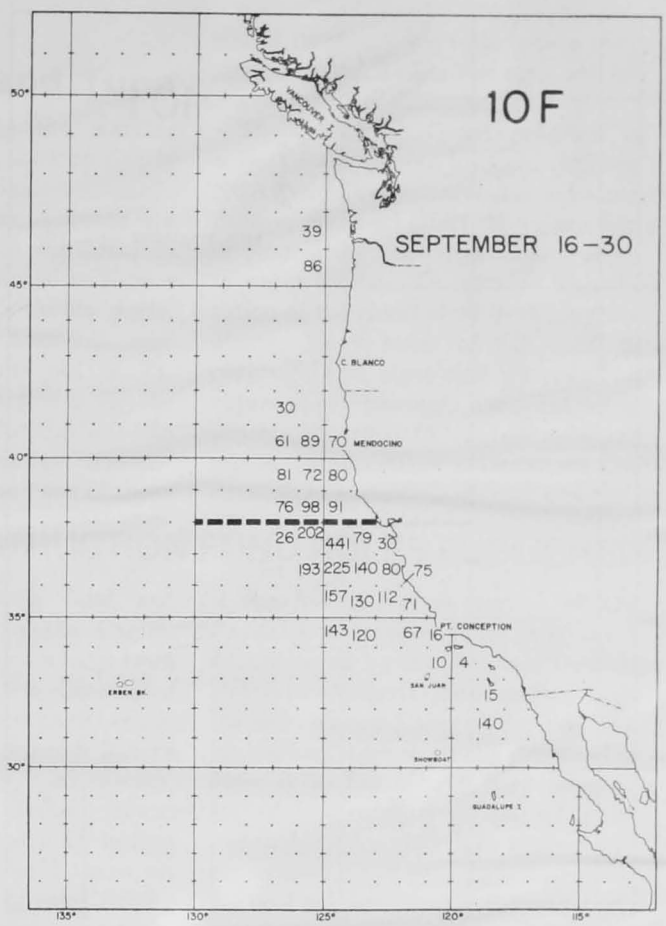
Figure 10.—Nominal catch-per-unit effort of albacore tuna caught by U.S. jig vessels during 1970 in terms of a 45-foot jig vessel. Values given are mean number of fish caught per day by 15-day period and 1° quadrangle. Heavy dashed line indicates lat. 38° N.

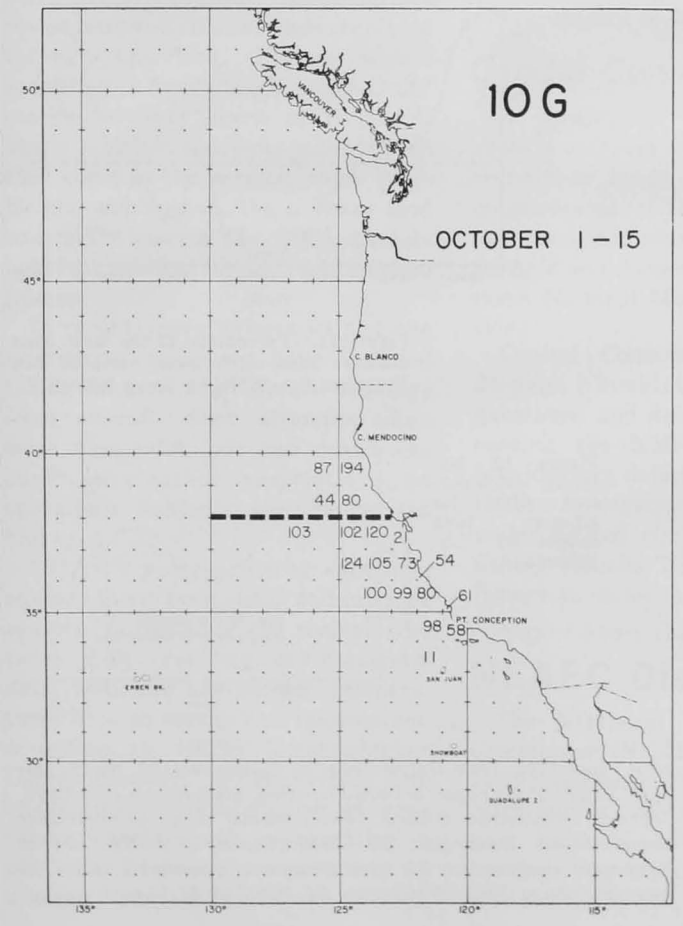


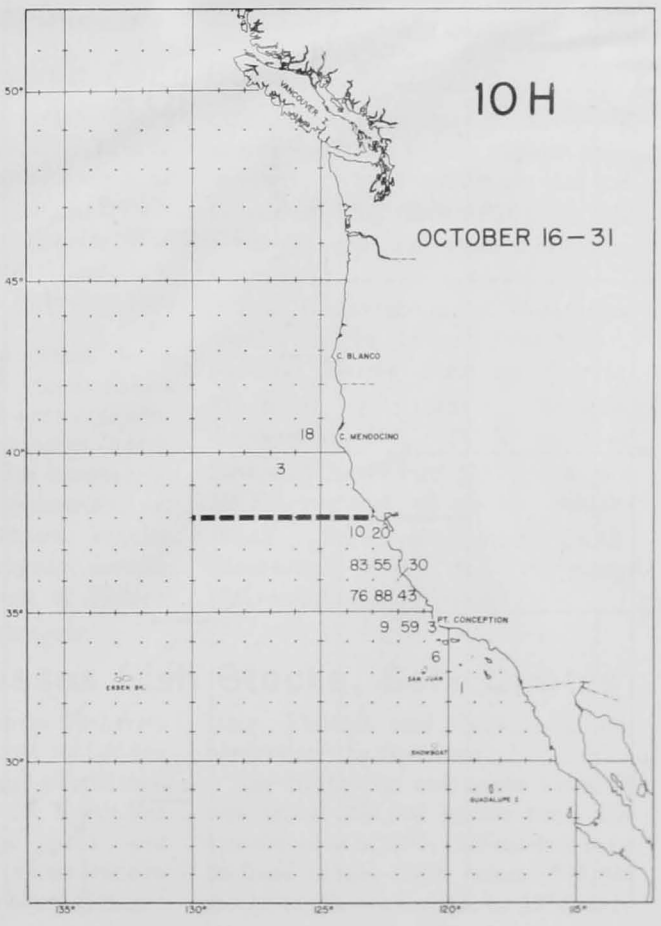


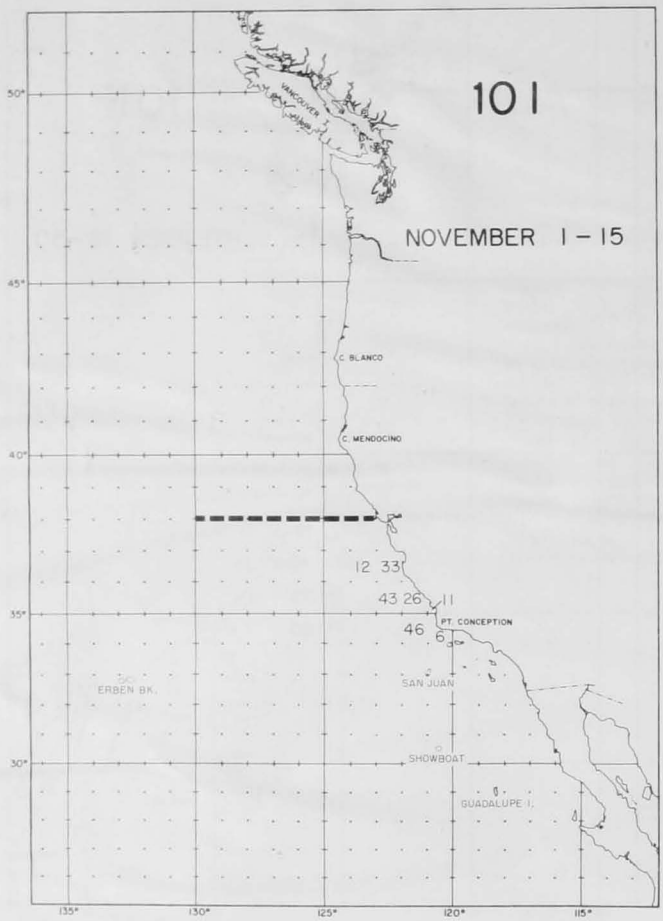


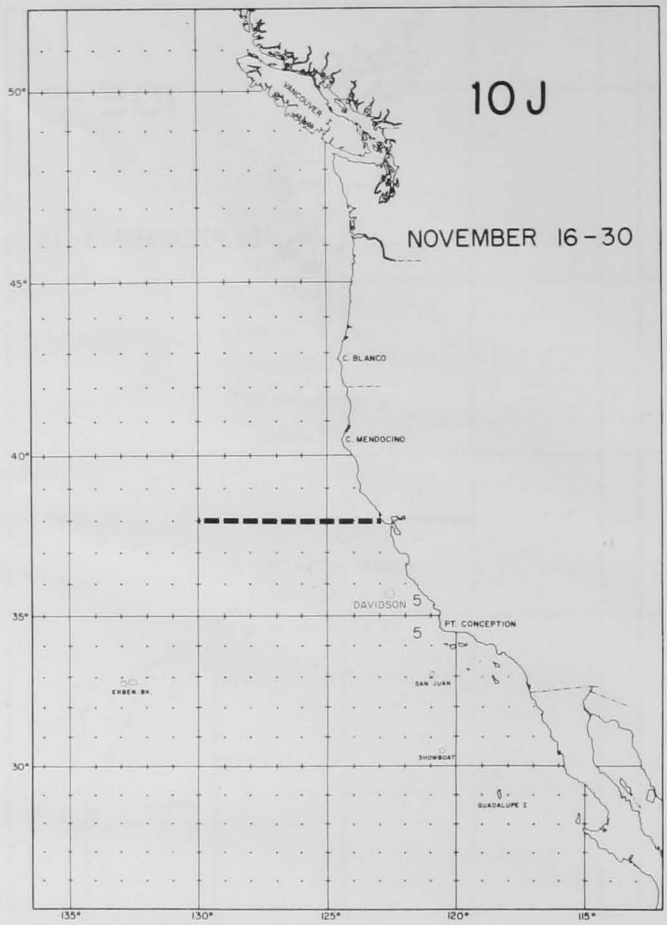

10E
SEPTEMBER 1–15
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SNOWBOAT
GUADALUPE I.
134
70
20
2
17
9 69 10
236 63 7
60 56 27
31 80 52 38
180 103 68 67 17
88 81 127 164 78 56
67 77 77 74 74
102 68 30 24 40 7
8
20
4
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°

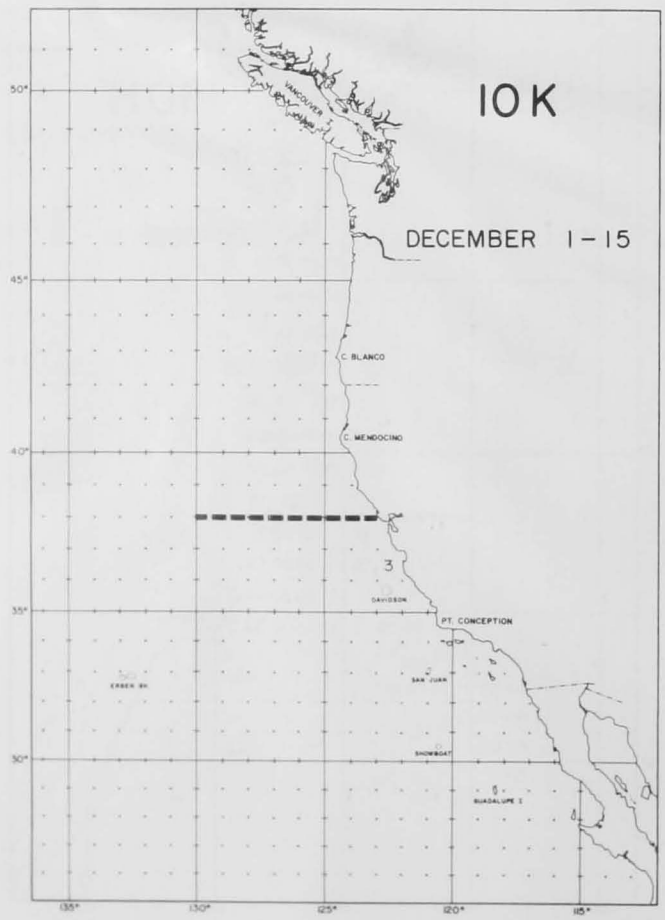

10F
SEPTEMBER 16–30
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SNOWBOAT
GUADALUPE I.
39
86
30
61 89 70
81 72 80
76 98 91
26 202 441 79 30
193 225 140 80 75
157 130 112 71
143 120 67 16
10 4
15
140
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


10G
OCTOBER 1–15
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SNOWBOAT
GUADALUPE I.
87 194
44 80
103 102 120 21
124 105 73 54
100 99 80 61
98 58
11
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°


10H
OCTOBER 16–31
VANCOUVER
C. BLANCO
C. MENDOCINO
PT. CONCEPTION
ERBEN BK.
SAN JUAN
SNOWBOAT
GUADALUPE I.
18
3
10 20
83 55 30
76 88 43
9 59 3
6
1
50°
45°
40°
35°
30°
135°
130°
125°
120°
115°







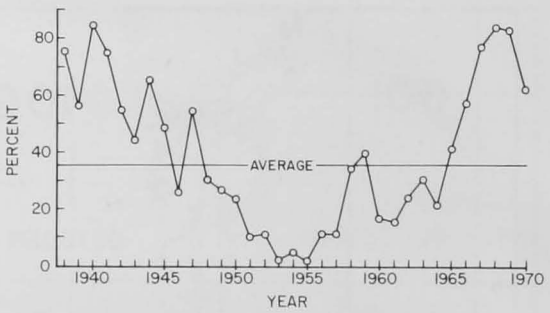
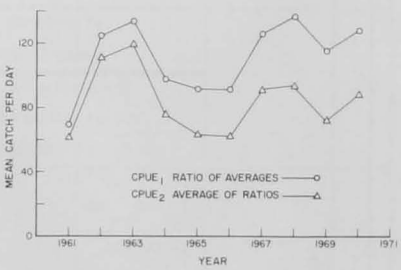


Figure 11.—Percentage of the west coast albacore tuna catch taken north of San Francisco (lat. 38°N) for years 1938-1970.

Figure 12.—Nominal catch-per-unit effort for albacore tuna caught by U.S. jigboats.



MFR Paper 1186. From Marine Fisheries Review, *Vol. 38, No. 5, May 1976. Copies of this paper, in limited numbers, are available from D825, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*